AGRICULTURAL ENGINEERING

JANUARY · 1948

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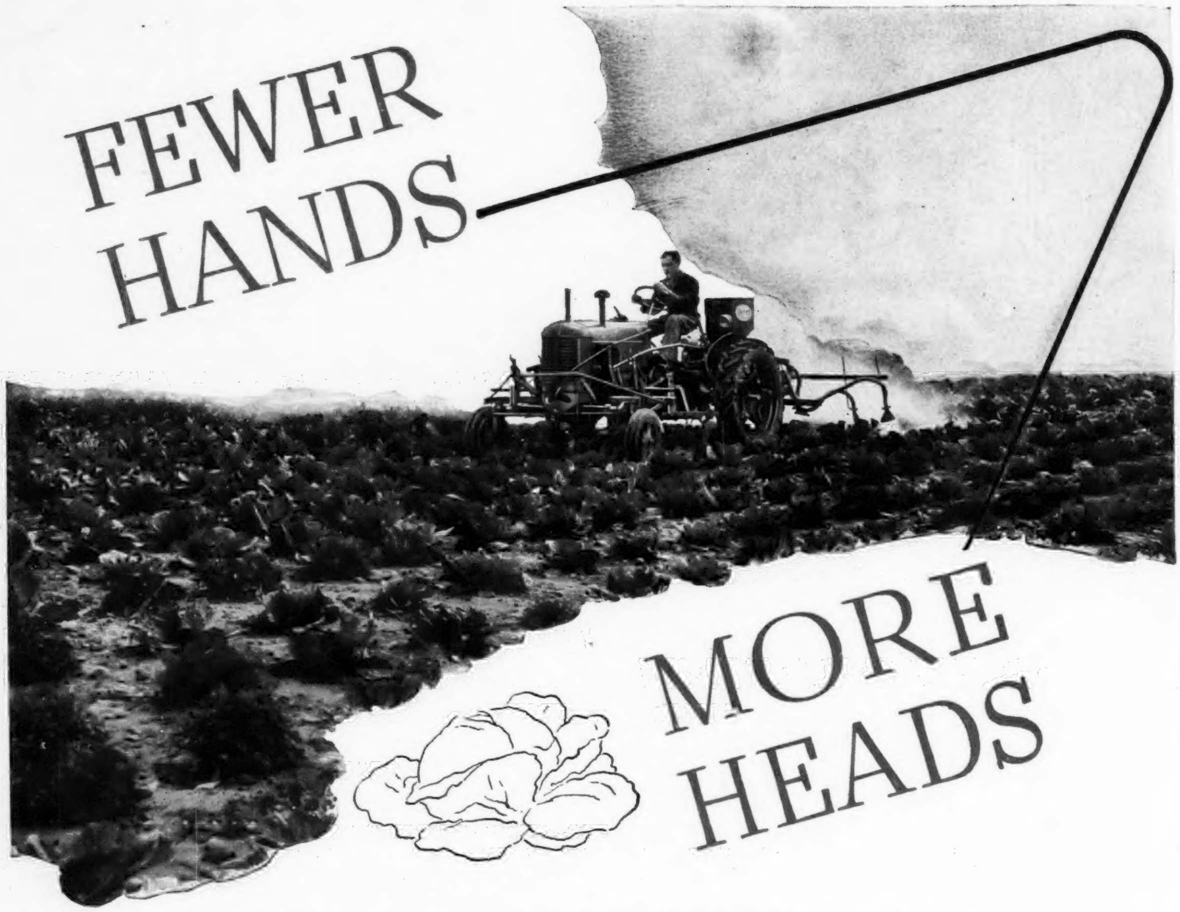

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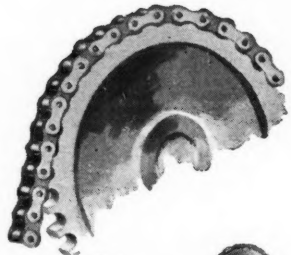

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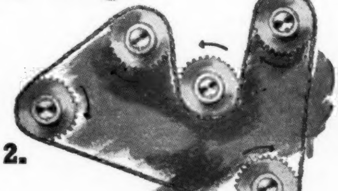

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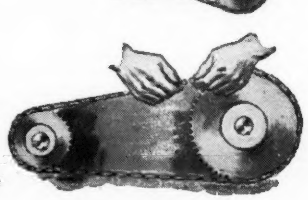

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AGRICULTURAL ENGINEERING

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RAYMOND OLNEY
Editor and Business Manager

EDITORIAL

Some Ironies of Soil Conservation

CONSERVATIONISTS are an unique and useful but unenviable minority in America.

To the extent that their efforts interfere with immediate individual profit by wasteful exploitation, they are positively damned as meddlers in other people's business.

To the extent that their efforts are timely and ahead of the pinch of actual shortage, when conservation could pay highest returns at lowest cost, they are damned by public indifference as unnecessary and unimportant.

To the extent that their efforts are not successful, they are damned by implication for failure to state their case energetically and persuasively enough to have overcome antagonism and indifference, and to have commanded the required support.

Soil conservation has won limited and grudging support only as a last desperate measure after the damage already done has become painfully obvious. As yet, few seem to see soil conservation as a phase of the conservation of human life.

Soil erosion may be measured physically in tons of the best topsoil unclaimed, in effect, on farms surveyed and deeded to establish claim to the exact square foot of surface area involved.

It may be interpreted economically in terms of real dollar values slipping through the fingers of farmers who count and guard to the last penny the cash symbols of value which come their way.

It may be classified socially as one of those abuses of newfound freedom which helps to weaken the foundations of freedom.

The technical know-how for effective soil conservation has been developed, and thoroughly demonstrated in all critical areas and under varied conditions. The information has been made widely available. But percentagewise, the area effectively protected is still small.

The capital value to be saved in most cases far exceeds the cost of conservation measures. But even with the encouragement of government subsidy, there is no rush of smart money to invest another dollar to save five or ten.

Neglect of their soil by landowners just does not check with their reaction to other forms of capital losses. When one of their buildings is on fire, they don't ordinarily wait to see how far they can let it burn before trying to put out the fire.

When a farmer has a crop in excess of his storage capacity, or other property subject to rapid depreciation, he usually jumps at a chance to sell it at a good figure, while it still has some salable value. But some of the same farmers with more land than they can or will protect from depreciation are missing good chances to sell it at present inflated prices to others who might give it some protection.

And some farmers who are too civilized to deliberately leave their children or grandchildren in a burning building, seem to have little or no feeling about leaving them to the more prolonged agonies of a washed-out farm.

The only apparent answer is that these farmers, however much they may have heard about soil conservation, simply cannot or will not believe that the most valuable part of their farms is slipping away from them under their own eyes, without their seeing it happen.

Yes, the soil conservation men still have a big and thankless job on their hands, and further improvement of the techniques of conservation is only a part of it. Actually, the crop-producing capacity of a lot of so-called real estate is more perishable, in proportion to its possible life under good care, than a ripe strawberry or a quart of fresh milk. And until this fact is thoroughly drilled into the consciousness of the majority of landowners and operators, and agricultural leaders, a lot of our soil is going to continue to go downhill, literally and figuratively.

Meeting Indications

THE Winter Meeting of the American Society of Agricultural Engineers in Chicago last month was notable for a strong showing of interest from related industry. In a record-breaking registration of 664, more than 71 per cent were men from industries allied to our field, as distinguished from those in state, federal, and other non-commercial agencies, and a representation of college students.

An unprecedented work load and limitations on travelling expenses held down the representation of men in public service.

Specifically, 472 members and guests from private industry, in 224 different organizations, were registered.

A number of inferences might be drawn from the interest shown. Perhaps the most significant is its indication of a growing appreciation of the extent to which engineering is involved in the operations of agriculture; in the conservation of its resources; and in the design, development, construction, distribution, and use of its mechanical, electrical, and structural equipment.

Wherever and however private enterprise is operating in, or providing products or services for agriculture, it is encountering agricultural engineering problems.

In actual farming operations on any basis beyond rule-of-thumb calculations, it quickly runs into drainage, soil conservation, or irrigation problems; functional requirements and special adaptations of equipment and structures; lighting, power, and control questions, and over-all operating efficiency matters which in effect involve principles of production engineering.

In the farm operating equipment business there is a growing appreciation of the importance of meeting functional requirements. The equipment has to do a job in more than a haphazard sort of way. And to do so it has to be designed, built, sold, and serviced with careful attention to these functional requirements. The older farm equipment manufacturers have known this for a long time. Some of the smaller and newer manufacturers and distributors realize it, and some more of the newer manufacturers are going to learn it when the supply and demand situation adjusts to increase competition.

The same is true of farm building materials and equipment, and of electrical equipment and services. Even the manufacturers of component parts and of fertilizers and other chemicals for farm use are showing increasing interest in agricultural engineering as a factor influencing ultimate farm satisfaction with their products.

New developments in the biological and chemical sciences of agriculture are pushing for engineering help to advance their technically sound possibilities to the stage of economically sound farm practices.

Processors of farm products are showing increasing interest in things agricultural engineers can do to improve the quality, for their particular uses, of the farm products which are their raw materials.

Men in private industry and those in public service showed increasing appreciation of the fact that they are all working toward the same objective of helping farmers to perform an even greater economic service than they have in the past, and to earn correspondingly increased satisfactions.

It is no wonder then that they should now welcome, more than ever, the opportunity provided in A.S.A.E. meetings, to get together to swap ideas, information, and experiences in this fast-moving field. The individual agricultural engineer interested in keeping up with the pace of his profession will be present if at all possible. And the business interested in rendering a genuine economic service, in any way influenced by agricultural engineering, can scarcely afford to miss being represented and having its engineers identified with these gatherings for technical progress.

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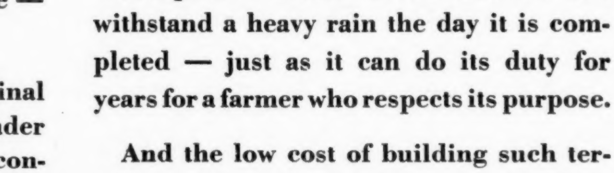

AGRICULTURAL ENGINEERING

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The Storage of Corncobs and Other Agricultural Residues for Industrial Use

By J. W. Dunning, P. Winter, and D. Dallas

THE Synthetic Liquid Fuels Project under the Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture, is a part of a broad national program for large-scale research on the production of synthetic liquid fuels from non-petroleum sources. The purpose of this project is to determine the manufacturing steps and costs of a process[1*] for the hydrolysis of agricultural residues to sugars for conversion into liquid fuels. To determine the manufacturing steps and costs of this hydrolysis process, a semiworks plant has been constructed at Peoria, Ill., which has an operating capacity of 3.3 tons of agricultural residues in an 8-hr day. This semiworks plant, an interior view of which is shown in Fig. 1, has now started operations.

Many questions have been asked about the availability and storage of agricultural residues for the saccharification process if and when the process might be used on an industrial scale requiring 50,000 to 100,000 tons of agricultural residues per year. Data on the annual production of agricultural residues[2] show that about 100 million tons of agricultural residues is available annually in the United States for industrial use with an equal amount left on the farms. It has been estimated that somewhat less than 2 million tons, or about 1.2 per cent of the total annual production of agricultural residues, actually find industrial use[3]. Since preliminary data indicate that about 90 gal of liquid fuels can be made from 1 ton of agricultural residues, there is a *potential* annual supply of 9 billion gallons of liquid fuels from the agricultural residues annually available in the United States for industrial use. This *potential* supply is not considered by the authors as an overnight reality or even as a future possibility in normal times. It is a possibility, however, which might be of extreme value during a national emergency.

Yet this question remains: Are any of these residues readily available at a cost low enough, and in sufficient quantity, to be used by an industrial saccharification process? Three criteria were employed to judge the "availability" of residues for the process: (1) The residues must be already collected at a processing plant or on the farm; (2) sufficient amounts of the residues must be located within an area small enough to insure relatively low transportation costs of 50,000 to 100,000 tons annually of the residues to the saccharification plant, and (3) the residues collected in the restricted areas must be low enough in price to permit a reasonable profit from the saccharification operation.

Peanut shells, flax shives, rice hulls, and other agricultural residues accumulate at processing plants but generally in amounts too small and in areas too scattered to provide the *sole* raw material for a saccharification plant. Cottonseed hulls accumulate in large amounts throughout the southern states, but the bulk of these hulls go into the feed industry at a price that prevents competitive buying by chemical industries.

About 300,000 tons of bagasse annually accumulate at sugar-cane mills in restricted areas in Louisiana. This amount of bagasse, of course, is over and above that sold to insulating board manufacturers. More than 80,000 tons of bagasse annually accumulate at Clewiston, Fla.

Approximately 500,000 tons of corncobs are annually available from county elevators and farms in the east-central section of Illinois. Cities in this area may annually obtain more than 200,000 tons of cobs within radii of 50 miles. Approximately 50,000 tons of cobs annually accumulate in southwestern Iowa at country elevators and on farms[4].

The bulk of the corncobs that accumulate at country elevators presents a disposal problem, and the cobs generally are burned in incinerators. There are, however, several corncob grinding mills in the Middle West, each grinding from 2,000 to 8,000 tons a year. Some of these cobs are obtained from elevators and some from farms where an accumulation of cobs over and above that required for fuel, feeding, and other purposes presents a disposal problem. During the past several years most of these ground cobs were shipped to a firm in Tennessee as a raw material for the production of furfural. A smaller part of the crushed cobs, sifted to different degrees of fineness, was sold for chicken litter, for a mild abrasive in soap manufacture, for soft-grit blasting, for filler in mixed feeds, as a mulching material, etc.

Since a corncob grinding mill may crush only 2,000 to 8,000 tons of cobs a year, it need not be located in an area of a large supply of cobs. The mills are actually scattered throughout the Middle West and utilize the cobs that accumulate in a relatively small area.

Fig. 1 An interior view of the semiworks plant constructed as a part of the USDA Synthetic Liquid Fuels Project

This paper was prepared expressly for AGRICULTURAL ENGINEERING, and reports a study conducted in cooperation with the Agricultural Residues Division, Northern Regional Research Laboratory. Requests for information on availability, storage, and other uses of agricultural residues should be addressed to the Northern Regional Research Laboratory, Peoria, Ill.

J. W. DUNNING, P. WINTER, and D. DALLAS are associated with the Synthetic Liquid Fuels Project, Bureau of Agriculture and Industrial Chemistry, U. S. Department of Agriculture.

*Superscript numbers refer to appended references.

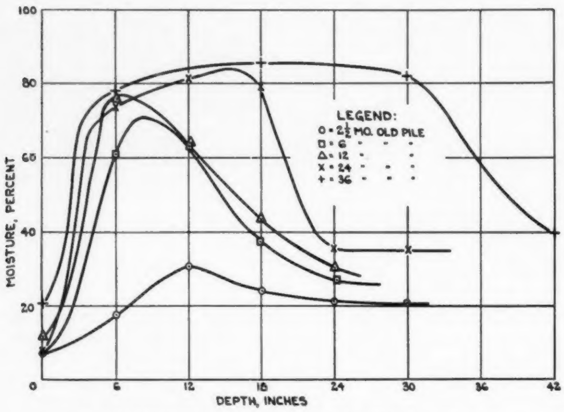


Fig. 2 Moisture content of corncobs stored outdoors

These data indicate that there are sufficient amounts of bagasse and corncobs that accumulate at processing plants located in restricted areas to supply from six to eight saccharification plants. There are, in addition, appreciable amounts of other residues; for example, flax shives and hulls of rice, cottonseed, oats, and peanuts that accumulate at processing plants which could be used to supplement the main supply of raw materials for the saccharification operation.

Some of these residues such as sugar-cane bagasse, oat hulls, cottonseed hulls, and various straws have been used for a number of years in certain industrial markets and their storage is not now a major issue. The storage of corncobs, however, has received very little if any attention. The storage of cobs is of immediate interest to the synthetic liquid fuels semiworks plant in Peoria because corncobs are being used for the initial plant operations. This problem is also of interest because the large tonnage of corncobs available in the Middle West makes this section a logical location for a future full-scale saccharification plant if such a plant were to materialize.

More than 60 per cent of the corncobs that result from corn shelling in the Middle West accumulate during October, November, December, and January[4]. This situation necessitates the storage of approximately a 6-month supply of corncobs by any large corncob processing plant. If a corncob saccharification plant requires 100,000 tons of cobs a year, storage capacity for approximately 50,000 tons of cobs must be available. Assuming that corncobs weigh 13 lb per cu ft, 50,000 tons would require at least 7,700,000 cu ft of storage space. At 6c per cu ft, as the cost of the storage buildings, this would amount to $462,000. This high cost for storage made it advisable to ascertain the feasibility of storing corncobs outdoors.

Arrangements were made with various corncob grinding industries in the Middle West to inspect and sample their indoor and outdoor cob storage piles. Approximately 30,000 tons of cobs were sampled. Representative samples were taken at different points on the surface of each pile and other sets of samples were taken within the pile at 6-in intervals from the top to a depth of 42 in. The piles of corncobs sampled ranged in age from 2½ months to 3 years. Samples were taken during April and May. No appreciable rainfall occurred within the week preceding the sampling of outdoor storage piles.

Each sample was analyzed for moisture by drying to constant weight in an oven at 105C (degrees Centigrade). The samples were then saccharified by a modified rapid 72 per cent sulfuric acid method which gave the total sugars in each sample[5]. The total reducing sugars was determined by the Shaffer-Hartmann method[6]. The dextrose was removed by yeast fermentation leaving in the solution only pentoses which were determined by the Shaffer-Hartmann method. The amount of pentoses obtained directly from the analyses and the amount of dextrose obtained by difference between total sugars and pentoses were calculated to pentosans and cellulose, respectively. The analytical data from samples obtained at the same depths from different piles of the same age were averaged. The data presented are based, therefore, not on one but in many cases on several different piles of corncobs of the same age.

The data plotted in Fig. 2, showing the relation between moisture content of cobs and their position or level in the pile, indicate that the moisture content of cobs in the outer layers of outdoor piles is a function of age. The depth of these wet layers of cobs is also a function of age. The original moisture content of the cobs in the 2½-month-old piles averaged 12 per cent before outdoor storage. After 2½ months outdoor storage, the moisture of these cobs increased from 12 to 21 per cent. This tendency to increase in moisture because of rain or snowfall is partly neutralized by a combination of several factors among which are prevailing winds, direct exposure to sunlight, increased temperature of the pile due to exothermic mold growth, and occasional low atmospheric humidity. The data in Fig. 2 indicate that after a long period of outdoor storage the moisture content of the cobs within the pile levels off at about 33 per cent.

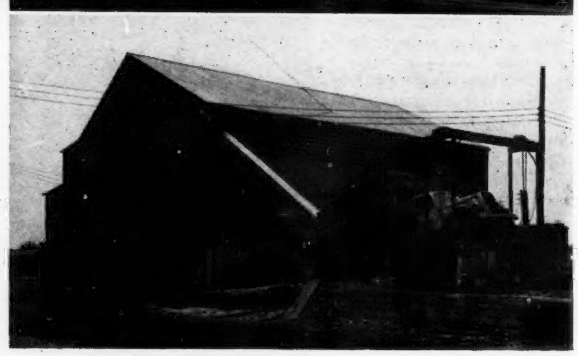
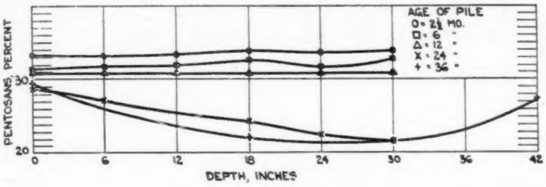


Fig. 3 *(Top)* A less expensive type of corncob storage building made of rough poles for uprights, wire fencing for sidewalls, and cross-braced with heavy wire. Capacity, 600 ton of cobs • Fig. 4 *(Center)* A relatively stable type of cob storage building with open sides made of squared timber uprights, snow fencing sidewalls backed by horizontal slats, and heavy wire cross braces. Capacity, about 300 tons of cobs • Fig. 5 *(Bottom)* A more expensive but very stable type of cob storage building with open slatting at bottom and top for ventilation. Capacity, from 800 to 1000 tons of cobs



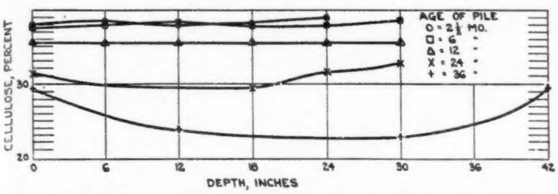


Fig. 6 *(Top)* Decomposition of pentosans in corncobs stored outdoors • Fig. 7 *(Bottom)* Decomposition of cellulose in corncobs stored outdoors

The effect of the wet outer layers of cobs on the moisture content of a cob pile as a whole deserves special consideration. In a very small, low pile of cobs the moisture of the outer layers would make a considerable difference in the average moisture content of the whole pile. In a large pyramidal pile the effect of the moisture in the outer layers of the pile on the average moisture content of the pile is negligible. It was calculated, for example, that a 6-month-old pile of cobs, 100 ft long, 50 ft wide, and 32.5 ft high, having an internal moisture content of 26 per cent, would average 27.1 per cent moisture when the wet outer layers of cobs were included.

Corncobs stored indoors decrease in moisture, provided the storage building is ventilated. As an example, one pile of corncobs decreased from 25 to 15 per cent moisture after 5 months of indoor storage. Yet another pile of cobs, stored indoors in a non-ventilated building, did not decrease in moisture after 5 months of storage. The storage of corncobs in non-ventilated buildings or in densely packed piles not only inhibits the escape of moisture but also the dissipation of heat. The heat produced by exothermic mold growth in a freely packed pile of moist corncobs is readily dissipated by natural ventilation. In densely packed piles, however, and particularly in piles of crushed cobs wherein the shucks and fines tend to collect in sections, this heat accumulates and theoretically can result in spontaneous combustion. Two fires in piles of corncobs, supposedly resulting from dense packing of fines and shucks, have been reported to the authors. Although the occurrence of fire is quite rare, temperatures as high as 150F (degrees Fahrenheit) have been observed in densely packed piles of moist cobs.

Moisture determinations on samples from 300 carloads of cobs that were shipped from the Middle West during a 3-yr period indicated that the corncobs average 18.5 per cent moisture, ranging from 7 to 40 per cent. The corncobs that contained approximately 7 per cent moisture were obtained from seed corn which had been exposed to a drying process. The wettest cobs were collected during the winter months and the driest cobs were obtained during the late spring and summer months.

Assuming that the bulk of corncobs that might be taken from the Middle West over an extended period of time would average 18 to 20 per cent moisture, it appears that, if these cobs were stored indoors for a period of 6 months, they might lose from 5 to 7 per cent moisture. If these same cobs were stored outdoors they might increase 3 to 5 per cent in moisture.

Figs. 3, 4, and 5 show three different types of corncob storage buildings used in the Middle West. Each of the buildings is designed to prevent rainfall from striking the top of the cob pile. The structure in Fig. 5 is the most efficient of the three in keeping rainfall from the sides of the cob pile. The structure in Fig. 3 is the least expensive, but also of least stable construction.

The data plotted in Fig. 6 show the relation between pentosan decomposition of cobs at different levels in outdoor storage piles and the age of the piles. The data plotted in Fig. 7 show the relation between cellulose decomposition of cobs at different levels in outdoor storage piles and age of the piles.

The average pentosan and cellulose contents for cobs at a 24-in depth and a 42-in depth are given in Table 1.

TABLE 1. PENTOSAN AND CELLULOSE VALUES* OF COBS AFTER OUTDOOR STORAGE

	24-inch depth		42-inch depth	
Age Months	Pentosans Per cent	Cellulose Per cent	Pentosans Per cent	Cellulose Per cent
2½	33.9	38.6	33.9	38.6
6	32.9	37.7	32.9	37.7
12	30.9	35.5	30.9	35.5
24	24.7	30.0		33.3
36	21.8	22.8	27.4	29.8

*All values on moisture-free basis.

There was a very slight decrease in the pentosan and cellulose values up to the 6-months storage. The pentosan and cellulose values decreased more after 6 months and particularly after 12 months of outdoor storage. This decrease was more noticeable in the 24-in depth samples, where the cobs were adjacent to a moist layer, than in the samples taken from the interior of a pile. In a large pile the decomposed outer layers of cobs did not appreciably affect the cellulose and peptosan content of the cobs in the pile taken as a whole.

Samples of corncobs taken at the base of outdoor storage piles were high in moisture and showed a marked decomposition of pentosans and cellulose. However, this high moisture content and pentosan and cellulose decomposition was noticeable only from the ground level up 3 to 6 in in the pile, depending upon the age of the pile.

In Table 2 is presented analytical data from random samples of corncobs that were taken from indoor storage piles.

TABLE 2. ANALYSIS OF INDOOR STORED CORNCOBS

Age Months	Moisture Per cent	Pentosans* Per cent	Cellulose* Per cent
1	15.6	33.8	36.2
1	16.6	32.2	33.8
5	8.4	31.6	38.8
5	10.5	32.2	37.9
6	23.3	31.4	39.1
6½	30.4	31.6	41.6
12	15.4	32.2	38.5
14	10.0	33.3	37.0
Average		32.2	37.9
± deviation		1.2	3.9

*All values on moisture-free basis.

No correlation between pentosan and cellulose contents and age could be made with these samples. It might be concluded that the degree of decomposition of pentosans and cellulose in the cobs in these indoor piles is small compared to the inherent difference in pentosan and cellulose contents of different cobs and compared to the indeterminate error in the method of analysis.

CONCLUSIONS

It is shown that the decomposition of pentosans and cellulose in corncobs stored outdoors is negligible up to 6 months of storage. Thereafter, the decomposition is apparent and becomes appreciable after 12 months of outdoor storage. It is concluded that the construction of large storage buildings at the site of a plant which utilizes 50,000 to 100,000 tons of corncobs a year is uneconomical in so far as protecting the cobs from the weather is concerned. If an industrial plant were to store its supply of cobs at points miles distant from the plant, an additional factor of transportation costs would be introduced. Although the pentosans and cellulose components of the cobs will not noticeably decompose up to 6 months of outdoor storage, the moisture content of the cobs will increase. The relative costs of storage buildings and increased transportation costs because of increased moisture would then have to be considered. *(Continued on page 17)*

Asbestos Cement Materials in Farm Building

By M. V. Engelbach
ASSOCIATE A.S.A.E.

ASBESTOS cement materials are "masonry materials"—actually thin sheets of a special type of concrete. They must be continually thought of and handled like what they are — concrete. Specifically, asbestos cement is an asbestos aggregate concrete composed of about 15 per cent chrysotile asbestos fiber, and 85 per cent portland cement, or, more properly, hydraulic cement. The hydraulic cement is the binder, and the asbestos fiber aggregate is the reinforcer, serving, in principle, the same purpose as steel reinforcing rods in ordinary concrete.

It is not necessary to describe portland cement, but just what asbestos is, is not so generally known. It is, however, the only known mineral fiber commercially usable as a true fiber. Broadly, it is an hydrous silicate of magnesia containing some water of crystalization. Its basic formula is $H_4Mg_3Si_2O_9$, but frequently it contains additional small proportions of iron, copper, aluminum, and other elements, and therefore occurs in several types, the most important of which are chrysotile and amosite.

There are only two basic processes for manufacturing asbestos cement materials in use today. They are the "wet" or "Hatschek" process and the "dry" or "Norton" process. In the "wet process" a slurry of water, asbestos fiber, and cement is conveyed to the Hatschek machine, which is something like a paper-making machine. Thin layers of wet asbestos and cement are built up and felted together on an accumulator roll to the desired thickness, and then removed for further processing. In the "dry" or "Norton" process, a thin layer of a dry mixture of asbestos and portland cement is spread on a moving blanket. Water is then sprayed on, and the material passes through leveling and gauging rolls. The asbestos cement in the form of a damp, flexible sheet — still plastic — issues from either of these machines.

Because any strong kneading force, such as might be applied by pressure rolls, might disrupt the bond between the asbestos fiber and the partially set portland cement, high-density asbestos cement materials generally are formed by placing the material between smooth or textured flat steel plates and subjecting them to a pressure of as much as 20,000 psi in a hydraulic press.

This final pressing process accomplishes several important things. It removes excess water, produces a smooth or textured finished surface on one side, and establishes the density of the finished product. It is important to remember that several types of asbestos cement products can be made from the standard mix of 15 per cent asbestos and 85 per cent portland cement, merely by applying various types and amounts of final pressure.

For example, and to demonstrate what can be accomplished by varying the pressure on the wet sheet, federal specifications for asbestos cement siding and roofing shingles and for corrugated and flat sheets are currently being written on a cooperative basis by the Federal Specification Board and the Engineering Committee of the Asbestos Cement Products Association. Flat asbestos cement sheets are being divided into three types which may be described as low, medium, and high density, ranging from approximately 98 to 128 lb per cu ft. In basic principle, the only difference between these types is their density. But the changes in density produce several distinct types of material. However, changes in the density of asbestos cement affect all the other physical characteristics including strength, moisture absorption, moisture expansion, flexibility, and workability.

Other processing results in many other products, types of products, and finishes, such as different colored products, autoclaving or steam curing, application of a ceramic type of glaze or imbedded mineral granules to shingles, and even the production of asbestos cement sewer and water pipe.

It must still be kept in mind that we are dealing with a portland cement concrete material. Therefore, it is well to remember that asbestos cement materials that are not steam cured require 28 days to cure and take their set, and grow harder and more dense with age.

Asbestos is reasonably resistant to acids, and therefore asbestos cement materials are fully as acid resistant as is ordinary concrete, and much more acid resistant than many other building materials. For that reason, asbestos cement is a good material to use as a lining for barns, milk houses, milk processing structures, poultry and hog housing, and the like.

An asbestos-cement-lined brooder house effectively prevents packing and reduces cannibalism, and when used for poultry dropping boards saves a great deal of work because poultry droppings are easily brushed off, as they do not stick tight.

Asbestos cement materials are practically everlasting. They are weatherproof in all climates, because they contain nothing but minerals, asbestos fiber and portland cement, and cannot rust, rot, or corrode. Insects and animals find no nourishment in asbestos cement, and therefore they are insect and moldproof, and even hard enough to discourage gnawing rodents.

Another important point is that asbestos cement materials require no paint to preserve them, and thus their use can save the cost of original painting, and the continuing expense of maintenance painting. These frequently total more than the cost of buying and erecting the asbestos cement materials in the first place Experience has proved that generally it is cheaper to build farm structures of asbestos cement materials, when first cost and especially maintenance costs are considered.

The hardness of asbestos cement materials, especially the type of flat asbestos board in general use, is about Brinell 20—about as hard as white oak. The proper nail can be driven through this type of asbestos cement board very easily. Knowing the hardness, it is easy to determine the proper type and size of the nail and fastener to use, and where to drive the nail. Siding and roof shingles come with factory-punched nail holes. Also, as asbestos cement is practically everlasting, common sense dictates the use of non-corrodible nails when applying these materials exposed to the weather or dampness.

Asbestos cement is easy to work and erect. For example, it may be cut easily and simply by scoring and breaking off, or it may be sawed with a hand saw, and filed, punched, and sheared. Seldom if ever does anything else need to be done.

One of the most important qualities of all asbestos cement materials is that they are firesafe. That means more than just fireproof or incombustible. A firesafe material really means a material that can prevent a fire from starting, and that is of utmost importance. The great problem is to prevent fires from starting. It is no satisfaction to know that the insurance company did not have to pay for a total loss when a "fireproof" building catches fire, if you die on the tenth floor from suffocation. Many fires both on farms and in the city can be prevented from starting if combustible parts of the structure are sheathed with an absolutely incombustible material that does not need paint, like asbestos cement, which serves the dual purpose of an ignition preventer and a durable wear surface.

Asbestos cement materials do not lose their shape under heat that would calcine gypsum board, completely consume wood and other combustible materials, and weaken sheet steel so that it would lose form.

The Underwriters Laboratories, Inc., has rated asbestos cement board as zero in combustibility, zero in flame spread, and zero in smoke production. Therefore, it is easy to see where these materials can be used as incombustible, ignition and fire-preventing covering for many combustible or ignitible parts of structures. Farm fires are frequent and costly. Farm structures sheathed inside and out— *(Continued on page 27)*

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New Developments in Garden Tractors

By W. J. Adams, Jr.
MEMBER A.S.A.E.

THE garden tractor, although a tool of long standing and development, is just beginning to come of age. The farm tractor, yielding to the demands for a tool to supplant the horse, passed through its stage of greatest development during the 1930's on a wide production scale. That development resulted in better and more efficient tractors at a cost within reach of nearly every large-acreage farmer.

The history of the garden tractor is about as old as that of the farm tractor, dating from the period of 1905 to 1915 when it was learned that the gasoline engine could be used to lessen the labors of man. The garden tractor evolved from the basic idea of adapting a gasoline engine to the hand cultivator or hoe.

Most of these early developments were built around the idea of using one or two traction wheels with the cultivating tools drawn behind in the conventional hand-tool or horse-drawn fashion. The handle assembly was retained and used to control the direction of travel while walking behind the tractor.

Up until recent years, the garden tractor was a relatively specialized machine and found its greatest market in the truck gardening or commercial growing areas. Many different models of tractors and attachments were built to suit the specialized conditions of these growers, and this fact, together with the relatively small outlet, resulted in low seasonal production.

New Fields of Usefulness. Supplementing use by the commercial growers, in recent years many new fields have been developed for the garden tractor. These new fields include the suburban or hobby farmer, the farmer or rancher, municipalities, institutions, and industries, and export.

In this highly industrial and centralized age of living, the pendulum appears to be swinging back to the good earth. Many people are looking to suburban properties for better living at lower cost, using their spare time at home for healthy recreation and profitable diversion. They look to the garden tractor as an aid in accomplishing the work required to maintain successfully such occupations and properties in the few hours available to them and, at the same time, to lift such work out of the class of drudgery.

The dirt farmer or rancher is finding the garden tractor to be an important supplementary tool to his larger farm tractors. In addition to using his garden tractor for maintaining the family garden plot, the farmer is finding it exceptionally practical as a portable or self-propelled power plant to paint buildings, mow lawns and fence rows, spray cattle, control weeds, and insects, remove snow, and for many other uses.

Municipalities, institutions, and industries are looking to the garden tractor as an all-purpose tool to maintain their gardens, parks, and lawns and remove snow.

In the export fields, especially South America, the garden tractor is just beginning to find its place, mainly in soil preparation, seeding and cultivating, but gradually it is being learned that in those fields also the garden tractor is a useful tool for many other purposes.

Development of Attachments. The consideration of the garden tractor as a portable and self-propelled power plant as well as a traction means for pulling ground working tools has brought about, or is bringing about, the development of many other accessory attachments such as the following:

1 Sickle-bar mower for mowing anything from fine grasses to tall weeds and light brush. These sickles are generally front mounted and range from 30 to 48 in cutting widths.

2 Reel-type lawnmower which is generally front mounted with cutting widths of 20 to 30 in. The most popular mowers have the cutting reel power-driven from the tractor engine.

3 Snow plow or bulldozer, which is a useful year-round tool, for snow removal in the winter and general levelling and grading of dirt at other times.

4 Wood saw for sawing up fire wood and general wood sawing purposes.

5 Air compressor for spraying paint, insecticides and chemical weed killers, pressure lubrication, and pumping up tires. Sprayers with actual deliveries of 1½ to 3 cfm up to 100 psi are the most popular sizes.

6 Pumps for transferring liquids and for irrigation purposes. The centrifugal pump is ideally suited for such low-head uses.

7 High pressure sprayers for insect and fungus control, and even for fire fighting. Pressures of at least 200 psi are needed to do an effective job of spraying, and so far the piston-type pumps are the only ones which will handle abrasive insecticides such as Bordeaux mixture.

8 Dusters for the distribution of powdered insecticides.

9 Hauling carts or trailers which will haul up to ½-ton loads, and riding sulkies for use with such front-mounted attachments as sickle bar and lawnmowers.

10 As a standby portable power unit for such uses as milking systems and water-supply systems.

Effect on Production. Because of the increased demand and fields of usefulness for the garden tractor, our total annual production has increased from a few hundred of any one model to many thousands. This increase in production has been accomplished, to a large extent, by reducing the number of tractor models to about one-half of those formerly offered. Due to wartime restrictions, very little opportunity was offer-

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Left: Tricycle garden tractor with front-mounted power unit • *Right:* Demonstration of short-turning radius of front wheel drive

ed during the past few years to permit changing designs to facilitate the increased production and as a consequence much is yet to be accomplished along this line.

Design Possibilities Resulting from Increased Production. The production of garden tractors has now reached or exceeded the break-even point. It is now possible to expend economically much larger amounts of money for tooling. In the past, most of the designs were centered around sand castings and bolted or hand-welded structures. In considering redesign for higher production, first thoughts should be given to product simplification. This involves study of the over-all problem from the standpoints of the functional usage, the limitations of the present design, and the available means of producing the various parts required.

In the production quantities now being considered, it is becoming increasingly clear that the scope of design can be enlarged to include manufacturing methods or processes other than sand casting, hand welding, and bolted structures, such as punch press stampings, pressed and deep-drawn steel parts, permanent mold and die castings, sintered parts by powder metallurgy, resistance and flash welding, induction hardening and brazing, furnace brazing, and automatic arc welding.

In the process of redesigning for high production, considerable attention must be given to the matter of appearance. Assuming equal performance and cost, the tractor with the "clean design" and pleasing appearance will have the greater customer acceptability. It is interesting to note that in the process of simplifying a design, such as eliminating single-purpose parts and combining them to perform multi-purpose functions, generally improved appearance follows with an over-all cost reduction.

Although most of the attention at this time is being directed towards the tractor, there is much need for product simplification in the ground-working tools and fittings. This field offers a great challenge to the garden tractor industry because this will require standardization on a wide and cooperative scale to overcome the inertia of the myriad of designs and types of tools which are currently being used as carryovers from hand-operated tools and horse-drawn implements. This particular phase is also being complicated by procurement difficulties. Most garden tractor implement designs were built around these specialized tools. Inability to obtain delivery many times requires a non-interchangeable change from another manufacturer to use a substitute.

Because the design of ground-working tools is dependent on so many intangibles and variables, the wide field experience gained by the ground-tool manufacturers is of prime importance in any program to standardize these tools for the garden tractor industry. Much can be done by selecting, out of the complete range, a few tools which will meet the widest fields of use, and then concentrate on these for product improvement, cost reduction, and full production.

Walking Types of Tractors. The opening up of the suburban farmer, supplementary farm tool, and non-farm fields has brought new emphasis to the small 1½ to 2-hp tractor. Tractors in this range weigh in the order of 150 to 250 lb. They can be handled as walking-type tractors without undue physical exertion. Considering their use for light soil preparation, seeding and cultivating purposes, they can do an admirable job for the non-commercial user. As a vehicle and power plant for such attachments as sickle mowers, lawnmowers, sprayers, etc., these small engines have adequate power not only for propelling purposes, but also for supplying power to the attachment.

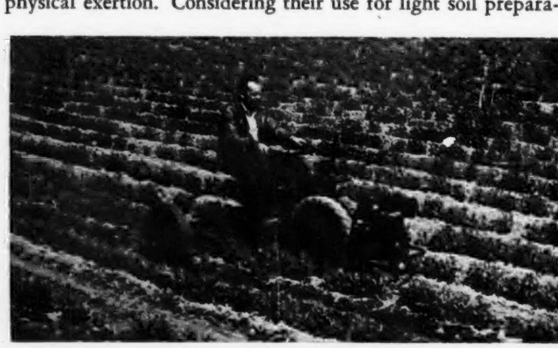
For a minimum of investment, attachments for these small garden tractors can offer the same advantages as the self-propelled, single-purpose types, without duplicating engines, transmission and clutching means, and traction wheels. It is of utmost importance, however, to provide means for easily mounting the attachment to the tractor and connecting up the necessary drives. One method is to provide a standard mounting adaptor and a power take-off sheave on the tractor so that all front-mounted attachments can be put into operation by literally snapping them on and connecting up one V belt. This should be made possible without need for any hand tools or wrenches. Complicated or difficult means of fitting attachments can easily defeat the purpose of the garden tractor as a multipurpose tool by creating such inconveniences as to make the single-purpose, self-propelled tool more desirable in spite of its higher investment. Another factor to be considered is that the small user may not be able to justify the purchase of a garden tractor for strictly ground-working purposes, but the fact that it can do so many other things for him may prompt him to buy. In this way, another tractor sale can be made, and, better yet, perhaps several additional attachments.

Tractors in the 3 to 4-hp range have found their use mainly in the commercial growers' fields. Here tractive effort in the range of 250 to 350 lb is necessary for proper soil preparation and cultivation. Most tractors in this class weigh from 400 to 550 lb. Tractors in this range are generally considered to be the practical limit in size and weight as walking types.

Because of the fact that many of these larger tractors are also being used for other purposes which require working in close quarters, as contrasted with row-crop work, the need for power-reversing means is being emphasized more and more. In many cases, it is physically impossible for one man to pull a 400 or 500-lb tractor backwards in soft or uneven ground.

From a safety standpoint, it would appear that reversing should be by momentary control only. The reversing speed should be considerably slower than the forward speed to prevent the tractor from overtaking the operator. By reversing slowly and by making it impossible to lock the tractor into reversing motion, the danger of accidents should be reduced to a minimum if normal care is used by the operator.

Most drawn-type ground-working attachments require gage wheels to overcome the torque reaction of the tractor. Although much thought has been directed towards a means for lifting the tools off the ground and supporting them on the gage wheels, most garden tractors do not incorporate such a feature. This problem is badly in need of solution, especially for the larger walking-type tractors, to reduce the physical effort required to hold the tools out of the ground while negotiating a sharp turn such as at the headland at the end of a row. The solution is complicated by the fact that the gage wheels should be fixed while cultivating in order to stabilize the tools, and yet they should be free to permit turns of a very short turning radius.




Left: Row-stradling application of tricycle garden tractor • *Right:* Disk attached to garden tractor.

To offset the added cost and complications of such a tool lift, it seems desirable to provide this as a more or less fixed part of the tractor drawbar system in order to eliminate duplication when adapting the tractor for use with various garden or field-type tools or implements.

Indeed, by adding these features to the larger and heavier sizes of walking tractors, they come close to being self-supporting four-wheel vehicles. And as the general problem is pursued, the riding-type tractor is more and more nearly approached.

Riding Types of Tractors. The larger farm-type riding tractors have made some inroads into the commercial truck growers field. These heavy tractors are fine for the soil preparation phases, but they have not proved to be the complete answer for close row-crop cultivation due to their heavy weight and limited tool visibility. Because of the present labor situation, however, many growers are finding it difficult to hire competent operators who are willing to walk behind a tractor all day long, and, as a consequence, many of these larger riding tractors are being used for row crops in spite of their visibility limitations and the inefficient utilization of their horsepower for such work.

The need for a small riding tractor, less than 800 lb in weight, is being emphasized more and more for row crop work. This need is also being felt for those farmers whose requirements are between the farm tractor and the small garden tractor.

RIDING TRACTORS OFFERED IN GARDEN TRACTOR FIELD

There have been some small riding tractors offered in the garden tractor field which in most instances have followed the general pattern of the larger wheel-type farm tractor, or have been built around the idea of adapting sulky arrangements to the conventional two-wheel walking tractor. Those garden tractors patterned after the conventional larger units are usually arranged with driving wheels in the rear, gear-selector-type transmissions, and steerable front wheels. Such units, though quite practical and sound, have not met with widespread use mainly due to their high cost in proportion to their horsepower. The combination of sulky arrangements on the two-wheel tractor generally restricts the maneuverability of these machines, necessitating increased headlands for turning. Our company has done an extensive amount of work in the development of a riding tractor that is sufficiently simple in design to meet the low-cost garden tractor field and yet meet all of the functional requirements.

This tractor is basically made up of a tricycle wheel arrangement. The front dual wheels are the driving wheels, which are supported by a pivot post to permit turning them slightly more than 90 degrees each way. The two front wheels are spaced closely together to avoid the necessity of providing differential action. Between these two front wheels is the gear-reduction transmission. Supported by a fin that projects forwardly between these wheels is the engine. The engine is coupled to the transmission by means of two pulleys which accommodate a flat belt to provide the drive connection for forward motion. By means of a cable connected to a control lever, the engine can be raised to a position to remove all belt tension for neutral or standstill. When raised further, the two pulleys enter into friction engagement to cause opposite rotation of the transmission shaft for reverse movement. In this way, the manipulation of a single control lever is all that is required to control the motion of this tractor.

Two rear wheels are attached to the rear of the main tubular frame and are adjustable for different row spacings. The operator's seat is also attached to the rear of the main frame at a point which places the operator's eyes only about 4½ ft above ground level.

Between the operator's seat and the front pivot post, a tool lift and a square tubular tool bar is provided. The tool lift is arranged with a parallelogram linkage so as to be able to adjust the depth of cut for the ground-working tools without changing their pitch. The range of lift is sufficient to provide for maximum depth of penetration and yet permit elevating the tools sufficiently high to negotiate uneven ground. The lift of the tool bar is accomplished by a manually controlled lever arranged with a notched quadrant to lock the tool bar in any fixed position.

Midway between the front and rear of the tubular frame is a steering wheel which is coupled to a sheave on the pivot post shaft to rotate the front wheels about a vertical axis to steer the tractor.

By mounting the engine ahead of and fixed with the front driving wheels, turns are negotiated without the need for clutches or differentials. The distribution of weight is concentrated on the front tires to obtain maximum utilization of dead weight for traction purposes. The front-wheel drive assures stable directional control especially in turning. This drive principle has proven to be most successful in the heavy rubber-tired, self-propelled, earth-moving scraper field.

The tricycle wheel arrangement makes for extreme maneuverability. This tractor has a turning radius of about 3½ ft. This feature is very important for working in close quarters, and minimizes the amount of land wasted for headlands in row-crop work.

Another reason for mounting the engine ahead of the front wheels is to make it possible to place the ground-working tools as close as possible to the front steering wheels. This is important for close row-crop cultivating work, to obtain good visibility and to reduce the lag in tool movement to a minimum.

This tractor is especially adapted to two or four-row close cultivating work. For more than two-row work, cultivators with floating gage wheels are recommended to maintain an even depth of cut in spite of unevenness of ground. For heavy field cultivation, the tractor is generally used as a single in-between-row unit.

So far, all of the conventional drawn tools and implements such as moldboard plows, disk harrows, spring and spike-tooth harrows, grader and snow-removal blades and garden or field-type cultivators have been developed to be attached to this tractor. A 20-in disk plow has also been developed which is new to the garden tractor field.

The front position of the engine makes it possible to drive attachments such as sickle-bar mowers; however, their development remains to be accomplished, since most of the effort to date has been placed on the ground-working use of the tractor.

The three-wheel tractor is our company's answer to the problem for a low-cost small tractor with the labor-saving features of a large tractor. There will be other developments in the garden tractor industry to meet the need for tractors to bridge the gap, but it is fairly certain that such developments will be further departures from the basic walking tractors. The immediate future holds a real challenge for the garden tractor industry and it will be interesting to see the results of this new phase of development.

Storage of Corncobs and Other Agricultural Residues

(Continued from page 13)

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Taking Stock of Farm Power and Machinery Research

A SYMPOSIUM

By L. W. Hurlbut
MEMBER A.S.A.E.

THE requisites for quality research are good men, fundamental problems, sound thinking, and carefully controlled experiments. These requisites indicate that research is largely a thought process. Man by his thinking must first define the fundamental problem; then by the same power provide the solution. Experiment serves to check the logic developed. Considering these facts, plus the great scope of the agricultural industry, research of broad implications demands coordinated functioning of a group or groups of minds. This conclusion applies especially in the extensive field of agricultural engineering; there are few, if any, branches of the agricultural science in which cooperation and coordination of effort is so imperative.

Therefore, it seems logical that the most effective cooperative effort of the state, federal, and industry research agencies can be gained by coordinated functioning of the minds of technical representatives in order that the technical aspects of each problem may have competent attention. Such cooperation cannot become fully effective, however, without definite planning for an action agency. Some progress in cooperative effort has manifested itself in the form of technical committees. However, limited observation of the functioning of such committees indicate that a lack of an action agency and finances limit their effectiveness.

Well-recognized human limitations in the field of research are:

1 Inability to detect and select problems with far-reaching fundamental implications.

2 An inclination to tackle a problem without clearly defining it and considering all fundamental facts.

3 A lack of training in fundamental research methods and a lack of knowledge of research procedures.

4 A lack of balance between time for "activities" and time for "analysis". Primary causes for this condition are split interests plus the perpetual demand for quantity production and public contact.

Improvement in administrative planning can do much toward reducing these limitations.

It is a well-recognized fact that quality research cannot be had without a clearly defined quality problem. In my opinion, the recognition of problems embodying broad and fundamental implications will result from logic applied in one or more of the following general problem areas:

I. A STUDY OF POTENTIALITIES OF AREAS

Agricultural research proposes to improve rural life, promote the prosperity of agriculture, and contribute to the welfare of society as a whole. Therefore, a need exists for analyzing the economy of sizable areas in the light of their resources and opportunities. Evaluation of the importance of natural resources, crops, and industries which have a sound functional relation to the economic, social, and agricultural situation in a given area is the first step.

Careful consideration must be given to programs which will contribute to creative and profitable employment in these areas. The sociological, psychological, strategic, as well as economic aspects of rural living deserves further fundamental consideration before we become too soundly convinced that we are committed to large land units under one ownership. Engineering developments can exert tremendous forces in either direction. We want it to be the proper direction. In other words, we need research of a very broad nature to guide the functional type of research.

II. AN ANALYSIS OF POTENTIALITIES OF ENTERPRISES

Much of the value of research comes from increasing efficiency and reducing the unit cost of production. In the field of power and machinery, we have taken large and rapid strides in the mechanization of "hand methods" and "horse methods" of production. Opportunities for improvement in the future will become apparent through analysis of the potentialities of production enterprises. For example, we have mechanized corn production following the pattern long established by the hand and animal modes of production. We need to know more about the possibilities of growing a heavy population of smaller corn plants yielding small ears which can be harvested with a combine harvester. Such a plan implies increased yields, lower production costs by way of less cultivation, increased use of equipment, fewer harvesting machines, and the simplification of farm storage problems. We need fundamental facts which will permit us to substitute sound over-all planning for custom and prejudice. Similar potentialities exist in all other production enterprises.

In addition, we need to rationalize the farming techniques in terms of standards which will provide a basis for a quick and accurate determination of the amount of work required for highly efficient farm operations. By such standards it would make possible reasonably accurate comparisons of efficiencies of labor and machinery without detailed account keeping. Such standards would do much to reduce the farmers' huge mechanical-agricultural-economic problem and permit them to concentrate on investment ceilings instead of only "machinery costs".

III. A DETAILED ANALYSIS OF PRODUCTION METHODS

A study of production equipment for the farm divides into three natural areas, namely,

1 Analysis of operations
2 Determination of design requirements
3 Power and machinery management.

The basic objective in agricultural production is increased efficiency with lower unit production cost; yet the acceptance of technological developments by the farmer has been disappointingly slow. This condition extends a challenge to public agencies and industry to find out why the beneficial developments have not been more widely sought.

Analysis of Operations. An analysis of operations will undoubtedly provide fundamental facts to help answer the perpetual and important question: "Why has not farm mechanization been more effective in raising our overall farming efficiency?" Unquestionably there is operational inefficiency resulting from a lack of harmony between field machines, hauling units, and storage units. We have done much to improve the efficiency of individual machines, but relatively little toward developing efficient and harmonious systems for production.

Other important problems in this area are as follows:

1 We need methods of tilth measurement which will enable the objective evaluation of the functioning efficiency of tillage machines and methods. Up to 30 hp-hr are expended per acre manipulating the soil by plowing to produce the mysterious condition described as tilth; then we continue with other operations of questionable value which partially or wholly destroy the mysterious thing we set out to build. There is a wealth of information relating to mechanics and metallurgy, paralleled by much information on soils and plant physiology but the abysmal space separating the two fields remains. This problem serves to illustrate that agricultural engineering is not primarily the older sciences of engineering

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and agriculture put to work in agriculture. Agricultural engineering must embody new fundamentals and techniques designed to meet the unique requirements of agriculture. We are late in joining with other agricultural sciences in the study of root ecology which will furnish the facts for establishing the functional and design requirements for mechanizing tillage operations correctly.

2 Develop a new scale by which to measure the over-all efficiency of crop production. This new scale must be based upon the accurate evaluation of all the components of the crop and methods used. Facts recently gained from studies of hay production have clearly shown the error of merely mechanizing an operation and neglecting the quality of the product. The loss in nutritive value of hay through present methods of handling, preserving, and storage is astounding.

3 Obtain more facts regarding fertilizer requirements and field placement requirements for the various crops. In my opinion this is not a study to be conducted independently by the agronomist.

4 Establish limits on seeding requirements for various crops. Such limits would provide basic design information as well as serve as a guide for the standardization of seeding machines.

5 Analyze the methods used in harvesting crops to determine whether or not the efficiency of machines and methods might be improved. For example, the harvesting of sorghum seed at safe storage moisture presents a problem because of the after-frost harvest periods. Preliminary tests indicate that the upper stem of the sorghum plant can be killed by passing a small but intense flame across it. A dry head on a green stalk may make possible the harvest of dry seed from a green plant.

Determination of Design Requirements. Public agencies can serve best in this area by conducting exploratory research involving broad changes in conventional machines or procedures. A few specific problems which deserve consideration are as follows:

1 The development of a lubricating system, or oilless bearings, which will require attention not more than once per week, or, better yet, once per season.

2 Incorporate built-in storage features in agricultural machine design. Such features would eliminate the necessity for machine sheds.

3 Objectively evaluate the fundamental factors relating plant production and soil packing by field machines.

4 Determine the draft, speed, and shock relationships for various field machines.

5 Analyze collectively the harvesting operations involving all crops to determine their points of similarity or difference based upon unit operations. The general similarity of units involved in this group of machines suggests the possibility of a machine which would, with minor changes, harvest and process all the grain and hay crops. Also, consideration should be given to the use of the product and desirable changes in plant characteristics.

Power and Machinery Management. This perpetual problem is one of operating existing tractors and machines at the greatest economy and efficiency for which they are built. This involves matching farm equipment types and sizes to job requirements, speed adjustment, loading, service routine, selection of lubricants and fuels, sequence of operations, working when conditions are favorable, and many other factors influencing cost and value of work done. Farm practice research involves much work, planning, and equipment, but offers a great opportunity for both quantity and quality results. A perpetual demand exists for more basic data for formulating principles and guides for obtaining more effective use of equipment on any specific job. Mechanization alone is no complete or sure-fire means to material prosperity. More specific problems in this area are as follows:

1 The problem of broadening the field for the use of the tractor deserves attention. Herewith we need to determine the relative values for some of the most important units of complimentary equipment for the tractor, including the belt pulley, the power take-off, the power lift, hauling equipment, loading equipment, etc.

2 Develop a more rational basis for selecting machines and power units. This problem demands more fundamental facts relating the value of timeliness and quality coupled with a statistical analysis of the time in days or hours available for doing the different jobs under favorable conditions.

3 Determine the potential demand for a reliable local farm service in relation to various degrees of diversification in the principal farm enterprises with the view of eliminating labor peaks, securing high quality help, and simplifying the machinery problems.

4 Development of management practices which will utilize fully the labor-saving features of farm machinery and power.

The farmers of today and of the future are committed to mechanical farming. Their success depends to a considerable extent upon the correct selection and effective use of their power and machinery. More knowledge of the technological developments in this field is a vital need for them.

Farm practice research offers a great opportunity for both quantity and quality results. A perpetual demand exists for more basic data for formulating principles and guides for obtaining more effective use of equipment on any specific job

By E. W. Tanquary
MEMBER A.S.A.E.

RESEARCH and engineering development are so closely allied it would be difficult to segregate contributions research agencies have made in the development of some of our modern farm machinery. A more recent development, the sugar beet harvester now being built by our company and described in AGRICULTURAL ENGINEERING for February, 1947, is one example of the benefits industry has gained from research work.

Before starting actual development International Harvester engineers and sales product men carefully investigated research studies at Davis, Calif., and one of the units built there was carefully followed in the field. The information gained was extremely valuable in establishing certain principles, and the assistance of H. B. Walker and his associates most helpful during field trials. A subsequent development was the sorting belt, an outgrowth of the sorting table introduced by the late E. M. Mervine at Fort Collins, Colo. The value of the research work on sugar beet planting equipment now being carried on and described by S. W. McBirney in AGRICULTURAL ENGINEERING for December, 1946, toward solving one of the major problems of mechanization of sugar beet production—that of reduction of thinning labor—is well recognized. Certainly the research work now being conducted on cotton mechanization will have an important bearing on the ultimate success of the mechanical cotton picker.

Development engineers have produced some very good beet harvesters and cotton pickers or cotton strippers and are constantly working toward improved operating efficiency and lower operating costs, but unless these other problems of improved planting, thinning, and cultivation are solved, mechanical harvesters will not reach the point of labor saving and aid in producing the crop competitively these important developments should justify.

Another more recent contribution is the research in corn planter population. One of the cardinal principles in the design of any corn planter was the precision drop to insure an accurate drop of the desired two, three, or four kernels per hill at least 95 per cent of the time.

From several state agricultural experiment stations we have information indicating it is of no great importance whether or not all the hills have exactly the same number of kernels per hill provided the total number of kernels per acre is correct. We would like more information on seed population in relation to fertility level, but with the information now available we feel the planter clutch, a remarkable little device with a tendency to beat its brains out every two or three years, particularly at the higher tractor speeds, can be eliminated. With the elimination of the planter clutch, which admittedly will reduce the extreme accuracy of drop per hill but will maintain the same accuracy per acre population, engineers can develop a true high-speed corn planter.

The foregoing are examples of research work that have been or will be of material benefit to the development engineer in producing improved farm machinery. From these examples it is apparent industry does have competent development engineers to develop to the point of commercial availability almost any type of farm equipment, and with their facilities for research in manufacturing processes and new materials are in better position than ever before to develop and manufacture suitable equipment for performing almost any farming operation once requirements for performing that operation are available. It is in gathering or developing the requirements for performing those operations and in forecasting changes, new trends, or improved methods of performing old established operations that research work is of the most value to the development engineer.

Due to the increasing use of direct-mounted implements so closely allied with the design of the tractor and common mounting or basic frames for different pieces of farm implements, efforts expended by the research engineer in the development of a complete piece of farm equipment, unless necessary to develop a basic principle, are largely wasted. When a piece of existing equipment is needed for study or mounting a special unit for research work, most manufacturers are most willing to cooperate with any public research agency.

Prior to starting actual development of any new piece of farm equipment, the sales organization, engineering department, and our own customers' research organization develop as much information as they can on the need for the new equipment—why it is necessary, what operation it should perform that cannot be handled with existing equipment, what crops it should handle, probable demand, what row spacings, under what conditions it must operate; in short, as much pertinent data as we can secure. Such information is gathered from our sales organization, research agencies, agricultural colleges, discussion with the farmer, and from our own past experience. Only after all the available information is studied is the general layout or over-all design agreed upon and the actual development started. If the results of research studies by the various experiment stations were coordinated and more readily accessible, it would be extremely helpful in planning the original development.

For example, let us assume we will start development of an implement for chemical weed control, a not unlikely project. Some of the things we would like to know are as follows:

1 What type of chemical is most effective and what is the approximate rate of application? Information of this type would be desirable to determine if a tank large enough to avoid too frequent refilling can be carried on the tractor, or if the tank must be so large as to require a trailing unit.

2 Is there a possibility of using the same tank and valve mechanism for chemical fertilizer application?

3 Effect of weed killers used before emergence of weeds. Should the application be made when planting, when cultivating, or both?

4 Effect of weed killer on trees or other desirable plant growth adjacent to treated areas. Can a fairly wide spray be used, or must it be carefully shielded?

5 What effect will the weed killer eventually have on the soil?

6 What type of weed killer should be used on various farm crops and vegetables?

ESTABLISHING BASIC DESIGN IS FIRST STEP

The development engineer, once the basic design is established, can develop a suitable piece of equipment for applying the weed killer and would spend sufficient time in the field to check the performance from a mechanical standpoint. A designing engineer has, however, several other projects under way, and consequently would be unable to spend sufficient time, nor would he have the facilities to determine the effect the weed killer would have on different crops under different weather conditions or the eventual effect on the soil. He would, therefore, necessarily rely on the agricultural research agencies for this information.

The relation of research to engineering development is extremely broad and it is difficult to make any specific recommendations, but the preceding comments were intended to convey examples of where research has proven of value in development work, phases of work the development engineer is in better position to handle, and what phases of the work can best be handled by the agricultural research engineer.

Summarizing, the following suggestions are offered for consideration:

1 Research projects are necessarily scattered over different experiment stations. This is important in order that we may observe the problem under different climatic conditions, different soils, and in line with farming practices in that section of the country. The reports should be coordinated, and where the results are different as much information as can be obtained given so that we can determine the reason for the different result. In some cases conflicting reports are received without sufficient information to indicate why the different results were obtained.

2 Progress reports should be issued periodically, even if necessary to state the information is compiled from the study to date, is not conclusive, and may be altered by different

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weather or climatic conditions. If circulation of the reports is deferred until the results are proven conclusive, the development engineer may have in the meantime placed his own interpretation on the problem and his company been committed to a design that might have been better had certain information been available at an earlier date.

3 A bulletin similar to that presented by R. B. Gray at the USDA Beltsville Industry Research Conference listing the research projects under way should be issued from time to time so that the development engineer can determine what projects are being worked on, at what stations, and whom to contact to discuss various projects and secure the benefits of their study.

If I may digress slightly from the subject assigned for the panel discussion, it was particularly gratifying to hear Mr. Meek devote a portion of his discussion to the importance of safety in their program at the Mississippi Delta Branch Experiment Station at Stoneville. In discussion with men from the Department of Agriculture and other experiment stations it is apparent there is a common interest in this work.

Development engineers are becoming more and more safety conscious, and as representatives of industry we want to assure you that any effort put forth by public research agencies in educating the farmer toward safer operation of farm machinery is fully appreciated and of the greatest value to the entire farm equipment industry.

By K. W. Anderson

MEMBER A.S.A.E.

TAKING stock of farm power and machinery research should be of vital interest to every one of us. Our common goal is greater achievement and more rapid progress. Since improved organization often contributes to this end, I am going to outline my conception of the obligations of the different segments of the group concerned with research in this field.

Being associated with the farm equipment industry, it seems proper to review first its responsibilities.

1 Design, develop, produce, and market farm equipment at a price which makes its use economically justified.

We serve the farmer as a supplier of the machine tools he requires in his highly specialized business of producing food and fiber. To the extent that our efforts measure up to his expectations we will continue to hold his patronage, since in general the farmer has neither the time, the facilities, or the desire to build his own equipment.

2 Follow closely the results of agricultural research by public service agencies and farmers in order that equipment for handling new practices can be made available as quickly as possible after the new practice is proven economically sound.

In this connection it is well to remember that the farm equipment industry is composed of well over 2000 manufacturers whose combined efforts are required to serve adequately the equipment needs of the farmer.

3 To assist the research worker in obtaining equipment for carrying out new agricultural practices which show promise. This may mean the adaptation of conventional equipment, with which the individual research man may not be familiar, could require a rather major alteration of conventional equipment to do the specific job or possibly the design of entirely new equipment if that seems necessary.

The extent of interest and participation by individual concerns will probably be governed by (a) possibilities of acceptance of the proposed new agricultural practices by farmers, (b) nature of equipment requirements and its relationship to items now being manufactured or to new items on which development work is contemplated, and (c) availability of personnel and facilities.

May I suggest that inquiries from research workers, for help in supplying equipment which might involve new design, be directed generally to that segment of the industry that would be affected most. It follows that a prompt reply and follow-up should be forthcoming from each individual concern so contacted.

4 To keep public research agencies informed as to the most important types of research from the industry's viewpoint. This is one obligation that is not difficult to fulfill and I believe it should receive serious consideration by all of us.

The responsibilities of the public service research worker might be outlined as follows:

1 Analyze and determine the requirements of various agricultural practices. As an example, (a) how should soil be prepared for various crops? (b) To what extent is it necessary to remove the husks and silks from mechanically picked corn? (c) How should hay be prepared for optimum feeding results?

2 Exchange information with other public research workers engaged in similar activities to obtain the benefit of their experiences and to accumulate data in a manner that will facilitate comparison.

3 Publish progress reports on research activities so that possible trends in agricultural practices may be observed before the practice is generally established.

4 Keep in close contact with that segment of the industry which will be most affected by the research activity.

5 Provide the public with general information about your activities and accomplishments so as to assure the moral and financial support you so well deserve.

It is recognized that public service research agencies have their problems. Operating funds fluctuate. They have certain program commitments that must be respected. It is oftentimes difficult to break down departmental lines within an institution even though it is common knowledge that research problems do not respect these same departmental lines. Many people in the farm equipment industry find it difficult to follow the various research activities, and there is a general feeling that the co-ordinating work which is now in progress is a step in the right direction and can possibly be expanded.

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By Arthur W. Turner

FELLOW A.S.A.E.

THE four stages of research, as outlined by Dr. H. J. Barre, are (1) functional or fundamental research, (2) application or design development, (3) utilization, and (4) methods engineering.

The place for federal agencies — and in this case the Agricultural Research Administration — is in functional or fundamental research. The state experiment stations work in the same field, although they go farther and carry on some application and utilization studies on a state or regional basis.

Federal and state experiment stations are agencies for public service research. The place of public service research is first to develop methods and procedures for doing a job. Following are examples of problems to which they should give attention:

1 When is the time to cut hay, from a plant-maturity standpoint, for silage or forage?

2 What are the conditioning requirements for storing and transporting a commodity?

3 What are the functional shelter requirements of farm animals?

4 What characteristics and applications of electricity or other energy will improve the viability and yield of a seed and plant?

5 What is a stand of cotton or of any other crop?

6 What are the harvesting requirements from a commodity standpoint for any commodity?

These examples indicate a pattern for public service research. Each of the problems stated calls for cooperative research between members of two or more of the subject-matter groups: agronomist, entomologist, plant pathologist, animal specialist, veterinarian, soils specialist, fertilizer specialist, chemist, and physicist, as well as the *(Continued on page 27)*

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Nation-Wide Conservation Drainage Operations

By John G. Sutton
MEMBER A.S.A.E.

FARMER interest in drainage is growing fast. In 1946, farm drains were installed on 752,662 acres of land in connection with farm conservation plans prepared by technicians of the U.S. Soil Conservation Service. This is two and one-half times the 1945 acreage increase. Construction of group drains in connection with the SCS program also increased in 1946, to a total of 750 mi for the year. Group drainage jobs completed in 1946 totaled 569 and provided outlet drainage for 419,451 acres.

We are often asked, "Where does drainage fit into the conservation program?" One answer is that conservation means using land in accordance with its capability and treating it in accordance with its needs. Much land is being eroded because, even though too steep for cultivation, it is being cultivated. Many farms contain steep lands that are being eroded, and flat, poorly drained bottom lands that produce nothing more than poor pasture. The conservation plans for these farms provide that their bottom lands shall be drained, where feasible, and used for row crops such as corn, cotton, and soybeans; and that longer rotations with more hay and pasture and fewer clean-cultivated crops shall be used on the steeper lands. Not only is this right conservation practice but it is profitable for the farmer, because it means better crop yields from both upland and lowland. It can easily be seen that good business management requires application of this principle on a large scale.

To reach the farmers owning flat, non-erodible lands that require drainage, it is necessary that cultivation of such lands be recognized as benefiting the public and be encouraged by public service agencies. In the past it has been recognized that land drainage benefits the public in several ways, including improved public health, enlarged local tax bases, opportunities for cities, towns, and businesses to develop on drained areas and by use of products from such areas, and improved condition of roads, railroads, and other utilities. These benefits have often been recognized in proceedings under state laws governing drainage works. An additional and very important public benefit, not now generally recognized, is that draining and cultivating flat, non-erodible lands facilitates conservation of steep, erodible lands. This additional measure of public benefit should be considered in connection with public aid in drainage work, especially at the national level.

According to Soil Conservation Service estimates, farmers in the United States are now cultivating 43,234,000 acres of land that should never be cultivated but should be retired to such uses as grazing and forestry; and in addition they are cultivating regularly 44,768,000 acres of land that should not be cultivated more than occasionally. I believe that, to provide the minimum needs of this country, large areas of land will have to be drained and put into cultivation within the next 30 years; that drainage will have to be improved on large additional areas already drained, and that additional areas will have to be developed for cultivation by clearing and by irrigation.

Of the 87 million acres of land now included in organized drainage enterprises, 29 million acres of cultivated land needs better drainage[1]. Wet, swamp, and overflow lands not included in such enterprises total 98 million acres, of which 20 million acres could be drained at reasonable cost and the remainder, under existing conditions, is more suitable for wildlife, forestry, and similar purposes. In the West, where regional prosperity depends upon successful management of irrigated lands, about 8 million acres of land in irrigation enterprises requires drainage. Thus lands that need better outlet drainage systems and could be drained by farmers and landowners economically total 57 million acres. At least 11 million additional acres of wet lands such as coastal marshes and stream bottoms could be drained if they were needed and financial assistance for drainage were provided from federal, state, or other sources. Over and above these estimates of land in need of community drainage are the farm lands needing farm drainage systems. Recent experience has shown that farm drainage often calls for outlay of capital and labor as great as that required by community outlets, or even greater.

Most of the funds supplied by Congress to the Soil Conservation Service are designated to be spent on furnishing technical assistance to soil conservation districts. The governing bodies of districts determine the priority of such assistance to farmers. Where several farmers have a common drainage-outlet problem, the district may assign technical assistance to them in installing a community drain. An outlet problem may be handled either under the drainage-enterprise provisions of a state law or by an informal organization.

The extent to which technical services of the Soil Conservation Service are available to farmers is indicated by the following: As of April 15, 1947, soil conservation districts numbered 1,838 and included 640,201,625 acres of land in farms; they included about 75 per cent of the total number of farms in this country and about 60 per cent of the total farm-land area.

The Soil Conservation Service assists soil conservation districts, first, in developing sound programs and work plans. Often, as a preliminary to such assistance, it must make a broad preliminary study to determine drainage needs and arrive at cost estimates[2]. The Service has cooperated with and advised state agencies and the Office of the Solicitor of the Department of Agriculture in regard to state drainage laws. It encourages other federal and state agencies to engage in sound agricultural drainage projects in accordance with

A dragline cutting a lateral to drain 450 acres of land on Scottswood farm near Lane, S. C.

Abridgment of a paper presented at the annual meeting of the American Society of Agricultural Engineers at Philadelphia, Pa., June, 1947, as a contribution of the Soil and Water Division.

(EDITOR'S NOTE: A few mimeographed copies of the complete paper are available on request to the Soil Conservation Service, Washington, D. C.)

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[1]Estimates from report of Committee on Drainage, A.S.A.E., 1946.

[2]Hauger, Roy L. Drainage Surveys in the Texas Gulf Coast Area. AGRICULTURAL ENGINEERING, vol. 28, No. 1, January, 1947.

their authorities and interests, and encourages private contractors to follow soil conservation practices wherever possible. It engages in drainage research projects, handled by its water conservation and disposal practices division, which are not discussed in this paper.

In the few locations where private engineers have an active interest in farm and group drainage work, the Soil Conservation Service welcomes the engineers' collaboration in drainage activities conforming to good conservation standards. It urges the soil conservation districts to cooperate with the engineers and encourage farmers to utilize their services in drawing up well-rounded drainage programs. Frequently the Service prepares preliminary reports on soils, crops, and land use; and a private engineer makes detailed surveys and plans, supervises construction, and handles all court and contract matters with reference to organized drainage districts.

A farm conservation plan made under soil conservation district supervision includes an agreement on the part of the farmer to use the land in accordance with its capability and to adopt the necessary conservation practices, including drainage. Soil conservation districts cannot furnish any funds to farmers. They can provide only technical assistance and information on proper land use and good conservation practices. The farmer must arrange for construction work at his own expense.

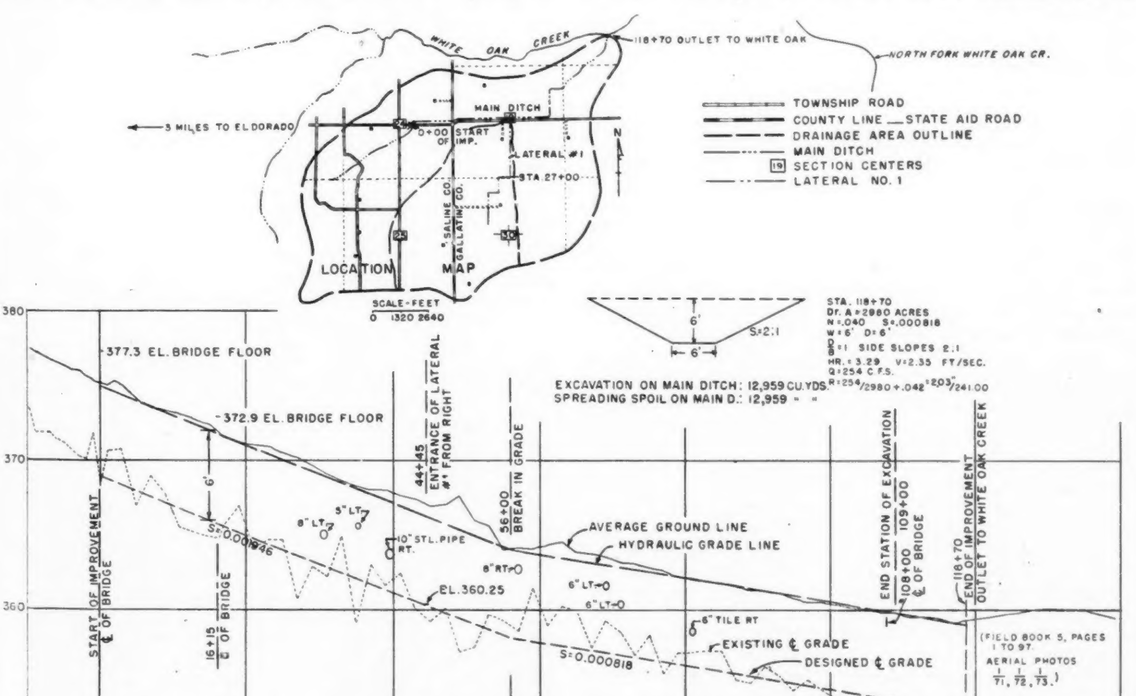
The Soil Conservation Service has been authorized by Congress to furnish or lend to soil conservation districts some equipment not generally owned by farmers. The Service makes available to the districts a number of draglines and heavy tractors adapted to drainage operations. The amount of equipment made available by the Service is limited, and most of the drainage operations have been carried on through contract work.

Farm drainage work is done as an integral part of the farm conservation plan. Before it is started, the suitability of soils for agricultural uses is determined by competent soils technicians. Other essential parts of conservation plans for drained lands usually include proper land use, required erosion control practices on watersheds, good crop rotations including legumes, soil-building practices, and adequate pastures. All these are planned by qualified technicians.

Let us picture how the operation proceeds. The farmer applies to the soil conservation district for a farm conservation plan. When his turn comes a farm conservation planner works with the farmer, and together they decide on the proper land use and agree on conservation practices to be installed. If one or more fields need drainage, Soil Conservation Service engineers supply the farm planner with instructions and guides for handling such work. If the drainage problem is complex, the Soil Conservation Service makes available the services of an engineer to prepare the necessary drainage plans.

Group drainage jobs in the soil conservation districts are those in which two or more farmers contribute to the construction and maintenance of an outlet drain. A preliminary report is usually prepared for such a job, providing information for determining (a) engineering feasibility of job, (b) economic feasibility, (c) extent of group participation, and (d) amount of Service assistance required. The group is encouraged to employ a private engineer, if practical, to carry on detailed surveys and plans and supervise construction. If the group of farmers can arrange to proceed with construction either by organizing a drainage district under state laws or through a voluntary organization, a plan of operation is prepared. This includes detailed designs and specifications.

The importance of maintenance is emphasized at every stage of farm and group jobs. One of the chief causes of drainage failures has been lack of maintenance. This problem has not by any means been solved, and it deserves the continued effort of engineers engaged in drainage. Progress has been made in adopting improvements in design and construction of drains to facilitate maintenance. Pasturing of ditches has been the most successful method of maintenance used. Interest is being shown in the use of tractor-drawn mowers similar to the highway mower, in use of chemicals such as



A sample plan-profile sheet prepared for a drainage district by engineers of the U. S. Soil Conservation Service

2-4-D to control undesirable vegetation, in burning, and in planting desirable grasses. Better light equipment is needed for light "bottom cleanout" and removal of shoals. Educational activities and further research on the subject are of fundamental importance.

For lands that need artificial drainage the advantages of tile drainage have long been recognized. A considerable part of the land that has been tiled, however, now needs major drainage improvements. Tile have been difficult to obtain. The demands have exceeded the capacity of tile plants. Last year, also, many tile plants made building-construction products instead of farm tile. Costs of tile have increased. In some counties the shortage of tile machines is a bottleneck in laying tile. Hand labor has been so costly that little hand laying has been done. In spite of these difficulties, tile drainage on farms is booming.

Table 1 shows data relating to some of the major accomplishments in the soil conservation district program in the United States for 1946 and totals to the end of the year.

TABLE 1. DRAINAGE ACCOMPLISHMENTS OF THE U. S. SOIL CONSERVATION SERVICE

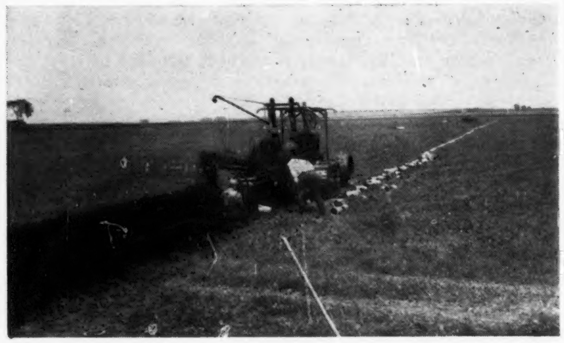
Item	For year 1946	Total to 12/31/46
FARM DRAINS		
Farm drainage planned, acres	1,586,040	2,956,232
Farm drains installed, acres	752,662	1,362,436
GROUP DRAINS PLANNED*		
Number of group jobs planned	737	1,711
Number of farms to be benefited	6,881	18,031
Area to be benefited, acres	949,996	2,242,289
Estimated total cost, dollars	5,422,759	9,393,483
GROUP DRAINS COMPLETED*		
Number of group jobs completed	569	1,066
Number of farms benefited	3,506	7,747
Area benefited, acres	419,451	897,264
Ditches and canals constructed, miles	750	1,513
Earth excavated, cubic yards	7,228,344	15,923,975
Clearing right-of-way, acres	928	2,525
Spoil banks leveled, cubic yards	3,916,266	7,227,821
Number of structures and bridges	682	1,082
Tile drains, linear feet	120,425	399,361

* Note accomplishments for group drains do not include work on farm drains.

On an average, the group drainage work planned in 1946 was estimated to cost $5.71 per acre. Farm drainage is proving more costly than many had expected. However, the results are developing land that can be cultivated safely without danger of serious erosion and are proving highly profitable to the farmer.

I think the best way to get acquainted with drainage operations in which the Soil Conservation Service is taking part is to consider a few individual and group jobs. Descriptions of such jobs, in different parts of the United States, follow.

Surface Drainage on Eastern Shore of Maryland and in Delaware. Numerous shallow surface-drainage systems have been established on the eastern shore of Maryland and in Delaware. Fields are drained by "bedding," or ridging in "lands," combined with shallow V drains. The principal advantage of the V drain is that it can usually be maintained by plowing. Typical of this class of farm drainage work is that on the Raymond West farm near Phillips Hill, Del., which included clearing and filling old ditches and grading low areas. On this farm the original plan was to develop major "header" ditches and use V ditches approximately 200 ft apart for field drainage. Most farm drains were dug with a dragline dredge. This work was more expensive, but undoubtedly provided drainage better than the minimum requirement. The total cost for clearing, grading, and excavating all farm drains amounted to approximately $16 per acre. Mr. West's neighbors became interested in improving the outlet called the "tax ditch." It is expected that Mr. West will pay at least $3 to $4 per acre more for that work. He still has most of his spoil banks to level, which will cost $3 to $4 per acre. While this is not necessary for drainage, it is part of the complete job. Altogether the costs for drainage and related operations will amount to nearly $25 per acre. Some farmers in the Delaware-Maryland area, whose land was easier to drain, have reported costs of surface drainage less than $10 per acre.



Laying tile drain on the farm of a district cooperator, John Gilkey, Edgar Co., Ill.

Several farmers near Cambridge, Md., reported increased yields after this kind of drainage. Mace Le Compt, the year after he drained 116 acres of cropland, reported a 100 per cent increase in wheat and tomato yields, and a 60 per cent increase in corn yields.

Drainage in the Southeastern Region. Interest in drainage by use of power equipment has increased greatly in the South in the last few years. Formerly, nearly all farm drainage in the South was by small hand-dug ditches with vertical sides and high spoil banks. Often work on such ditches was considered a wet-weather or off-season job. The high cost of labor during the last few years has encouraged greater use of draglines, tractors, and graders. Considerable work in tile drainage is under way in North Carolina, Virginia, and Kentucky. Many farm drainage systems using the V-type drains, bedding, and small dragline ditches are being constructed. All these types of drains are proving effective. Field trials and research are needed to determine the most economical system for soils in which more than one type can be used. In many areas outlet drains are required before adequate farm systems can be installed.

The Coastal Plain Soil Conservation District, N. C., assisted in draining 1,404 acres in Pitt County in 1946. This area was drained mostly by tile. About 200,000 ft of tile was installed during the year. About 100,000 ft was on the ground this spring ready for laying. We talked with J. C. Parker, who owns a 240-acre farm within this work unit. He tiled 25 acres of fine sandy loam at 100-ft spacing. He estimated his yields last year, after drainage, thus: Oats, 70 bu per acre; corn, 60 bu per acre; lespedeza, 600 lb of clean seed per acre. In wet years prior to drainage he made practically no crop on the wet land. Mr. Parker, in summarizing additional benefits, said he can run his tractor 500 yards through the drained field without turning; formerly he had to turn three times in this distance because of open drains. He has recovered use of 2 to 3 acres of land by filling up the open ditches in the field. He figured his saving due to elimination of hand maintenance of the open ditches filled up as one cent per foot per year, or $46 per year for 4,600 ft. He said he could get in the tiled fields earlier after rains and get crops planted earlier.

R. L. Eason, of Macclesfield, N. C., owns a 58-acre farm. He has a 7½-acre tobacco allotment, worth about $1,000 per acre on the local market. The land on which he had formerly grown his tobacco was sloping and had been eroded so badly he could not use it for that purpose any longer. He drained 4½ acres of wet land by tiling at 100-ft spacing, at a cost of $270. The value of his tobacco crop in this field increased from $280 per acre prior to drainage to $700 per acre after drainage. He started a soil-conserving rotation where erosion had begun and kept his tobacco production on a profitable basis. He said the tiling was worth ten times what it cost him.

The Gibson County Soil Conservation District, Tenn., planned an outlet ditch 4 to 5 ft deep for six owners, called the

Stallings lateral. The outlet ditch and seven laterals, requiring altogether removal of 26,400 cu yd of soil, were constructed as an informal group enterprise. About 160 acres of land was directly benefited. The cost averaged over $30 per acre drained. The owners estimate that the ditch resulted in 30 to 50 per cent increase in crop yields. Truck crops can be grown where it was impossible to grow crops before. One farm owner stated that his increased yields paid for his share of the work in one year. Prior to drainage, corn and sorghum were the only crops grown. The bottom land drained is now adapted to cotton, red clover, strawberries, tomatoes, alfalfa, and soybeans in a soil-conserving rotation. The better use of the bottom land relieves the upland of intensive use and permits better crop rotations on the six farms.

Similarly beneficial work was reported from Mississippi and Kentucky. Lynn Jeffries, Columbia, Ky., in 1945 drained with tile a 12-acre bottom where he had not previously produced a corn crop. In 1946 he produced 80 bu of corn per acre on this field. S. T. Hogan, chairman of the Monroe Soil Conservation District, Ky., drained a 25-acre field with ditches opened by dynamite at a cost of $230. This field, which was too wet for cultivation before drainage, produced 60 bu of corn per acre the first year after drainage. Another farmer nearby reported that his renter had asked to lease a drained bottom-land farm for five years.

Drainage in Upper Mississippi Valley Region. Drainage work in the Midwest states includes the drainage of upland prairies, of stream bottoms, and of glaciated country. Over half of the public drainage enterprises reported in the United States census of drainage are in this region. Many of the public drainage ditches have not been adequately maintained during the war period, and many outlet ditches are in bad condition. Tile drainage has long been used by farmers as the standard method of draining soils responsive to such treatment.

The Fountain County Soil Conservation District, Ind., assisted in a voluntary group enterprise called the Ward-Mann Ditch. Drainage of 640 acres of flat watershed required construction of an outlet ditch 6,000 ft long, with excavation of 8,288 cu yd of soil. The contract work cost $0.22 per cu yd. After drainage, production of agricultural crops on one 80-acre tract increased fully 50 per cent. On one 40-acre field the increase was 80 per cent. On another 40-acre tract that previously could be used only for pasture because the tile did not function, drainage made possible a soil-conserving rotation. Subsequent increase in crop production on the entire 640 acres was estimated at 30 to 50 per cent.

A difficult problem in drainage of potholes and depressional areas was encountered on the Fred Frank farm, Sun Prairie, Wis., in the Dane County Soil Conservation District. The maximum cut through the hill was 18.8 ft. The actual

Maintaining a drainage canal by burning vegetation in the Imperial Valley (Calif.) Irrigation District

cost of the system was about $2,700, or about $160 per acre for the 17 acres benefited. The system was completed in time for the 1945 crop season. While no engineer would ordinarily recommend such an expensive system, Mr. Frank, the owner, told us his increased returns the first two years had already repaid him the cost of the system. He figured his corn yields at 80 to 85 bu per acre for 1945 and 90 to 95 bu per acre for 1946. A few acres of the drained land was used for sweet corn for canning and for lima beans, which contributed to Mr. Frank's income.

Much of the land on this farm is steep and subject to erosion, but formerly had to be cultivated. The conservation plan now provides for a soil-conserving rotation on the steeper lands as well as on the bottom land, with more hay and pasture. Not all farmers can or should spend $160 per acre to drain a few acres. Mr. Frank had no other land available to make his farm a well-rounded conservation farm, and it paid off.

Another Wisconsin farmer had a 4-acre area of low, wet land in the center of a 9-acre field. The wet land could not be cropped, and this made the whole field difficult to work. The Soil Conservation Service staked out a tile system of 2,130 ft and instructed the farmer how the tile should be laid, since he was going to lay it himself. The district lent him tile spades, crumbers, and a tile hook. After drainage the field yielded 14 tons of sugar beets per acre, 65 bu of oats per acre, and 60 bu of barley per acre.

The Dodge County Soil Conservation District, Wis., furnished technical assistance to 17 farmers who wanted to drain 460 acres of wet land. The farmers organized a drainage district in accordance with the state drainage law. The open ditch required 30,125 cu yd of channel excavation. Spoil banks were leveled, and 27,960 ft of tile ranging in size from 5 to 10 in was laid. The job also required installation of two flumes and lowering of the flow line of a railroad bridge. The drainage system, including lateral tile spaced 100 ft on centers, cost the farmers an average of about $100 per acre. The greater part of the wet land had not been cropped before. Some of the yields reported by farmers on the new lands were 125 bu of corn per acre, 90 bu of oats per acre, 5 tons of sweet corn per acre, and twice as much corn silage as on the higher land. Yields on some of the marginal wet lands that had been cropped before were increased about one-third.

The East Agassiz Soil Conservation District, Minn., worked out a group drain benefiting six landowners. The job included 2.2 mi of main drain and 3.2 mi of laterals excavated by use of a ½-yd dragline, tractors, and 4 and 8-yd carry-all scrapers. One 40-acre field that had been a total loss in 1944, the owner stated, produced 45 bu of barley per acre in 1945, after drainage; an 80-acre field that had been a total loss in 1944 yielded 50 bu of oats in 1945. Another owner had planted a 40-acre field to potatoes in 1944, at a total loss. In 1945 half of this field produced 30 bu of wheat per acre and the other half 200 bu of potatoes per acre. Other owners cited similar yields following drainage.

Drainage in Louisiana. Louisiana has taken an important step in encouraging land drainage. State funds amounting to $5,000,000 were appropriated in 1945 and are supplied to parishes (counties) that undertake parish-wide drainage improvement programs. Parish drains include the outlet drainage works formerly handled by drainage districts in the state. In 1946 reports indicated that at least eight parishes had voted or were expected to vote bond issues totaling at least $2,100,000. To the funds voted by the parishes the state was to add $1,550,000, making a total of $3,650,000 indicated as available for drainage work in these parishes. Large-scale construction operations under this program began last year. Many of the parish drains empty into major outlets constructed by the Army Engineers. Soil conservation districts are making an important contribution to the program by furnishing technical assistance to farmers in installing necessary farm drains and small laterals in connection with farm conservation plans.

A typical system of surface drains was installed on the T. W. Humphries farm, near Monroe, La., in the Boeuf River Soil Conservation District. After an almost complete crop failure in 1945, Mr. Humphries applied to the soil conservation

district for assistance. A contour map was made, and technicians planned a surface drainage system. The ditches are of the V type and were cut with a large tractor and grader. The system cost about $5 per acre. About half this amount was returned to the owner through the PMA payments.

Mr. Humphries estimated that the increase in the 1946 yield of cotton due to drainage averaged 117 lb of lint cotton per acre, despite the fact that within the period from April to August rain fell on 59 days and amounted to 24.11 in. Mr. Humphries stated that he believed his crop would have failed completely had he not installed this system.

The work unit at Shreveport, La., reported that farm surface drainage systems covering 14 farms required excavation of 212,373 cu yd of dirt, or some 35 cu yd for each of the 6,097 acres benefited. When asked how much a man could afford to spend on drainage per acre, R. T. Douglas, of Gilliam, replied: "As much as it takes to do the job. If the land is badly in need of drainage, it is practically worthless without it, and will be worth the current price of land with it." T. P. Moore, Jr., of Hosston, said that although he cut only the main ditch and two laterals he increased his production "15 bales of cotton on approximately 50 acres." L. C. Hutchinson, of Caspiana, La., said, "The field I drained was the wettest on my farm; now it is the driest. Alfalfa doing fine."

Drainage Program of Red River Valley, N. D. In the Red River Valley of North Dakota, after a dry cycle of 12 years, a series of wet years began in 1941. During the dry cycle drains had been neglected and many ditches had been filled up, some by dust storms. Many road culverts were so small and were so high that the road fills formed obstructing dykes preventing drainage. From 1941 on, crop losses due to poor drainage and flooding were great. These losses, according to one estimate, exceeded 50 million dollars during 1941-44. The governor of the state came to Washington to obtain federal assistance. Some early work in which the Soil Conservation Service and the Agricultural Adjustment Administration cooperated proved that extensive drainage operations would be feasible. The state legislature provided $260,000 of state funds to assist in construction. Several soil conservation districts were organized in the valley. Considerable heavy equipment was lent to districts by the Soil Conservation Service. State funds were used for part of the construction work, and local funds were required for the remainder.

Technical assistance on group and farm jobs was furnished in accordance with usual district policies. In North Dakota 179 group drainage jobs had been planned through 1946, nearly all of which are in the Red River Valley. These jobs cover 790,849 acres, and the estimated construction cost is $1,150,566. At present 101 of these jobs, covering 286,595 acres, have been completed. Through 1946 the outlet drains constructed totalled 234 mi, compared with 500 mi planned, and excavation amounted to 2,981,000 cu yd of earth. Farm drains serving almost 200,000 acres have been completed.

It was estimated that crops were lost or seriously damaged on 634,000 acres in 1943 in the six North Dakota counties in which damage was most severe. The work completed and under way will assure outlet drainage for most of the area that was most seriously damaged. Much farm drainage in connection with farm conservation plans remains to be finished. Close cooperative relations between federal, state, and local agencies have contributed greatly to the success of the work.

One example is the Gust Johnson Group Drain, which benefits five farmers in the Rush River Soil Conservation District. These farmers requested assistance in establishing a community drainage ditch. The ditch was constructed by a private contractor with a dragline, at a cost of $2,608.05. It provides protection for 1,600 acres of good cropland, which had a return of over $20,000 in 1946. Most of the crops on this land had been a complete loss since 1941.

Drainage of Irrigated Lands. In many irrigated areas of the West the water table rises and causes increasing amounts of damage to lands and crops. In most cases this leads to a harmful accumulation of alkali salts. The rise of the water table may be due to seepage or to overirrigation. Prevention of such damage or reclamation of the damaged areas is not simple; many chemical and agronomic factors need to be considered. However, drainage is one of the most important means of achieving these results. Artificial drainage for removal of damaging water requires a permeable soil. For most irrigated lands a water table at least 6 to 10 ft deep is desirable. This requires deep drains. The types of drain used include open drains, tile systems, and pumped wells. It is estimated that some 8,000,000 acres of irrigated lands need improved drainage systems.

Al Foutz applied to the San Juan Soil Conservation District, N. M., for assistance in solving his seep problem. He told this to Harold Thatcher, work unit conservationist: "To make a long story short, District Chairman A. P. Blake had a farm planner come to my ranch and we talked over the cropping history. He asked for cropping and historical data, my ideas on what was causing the seep, and how far I wanted to go to clear it up. When we got through tramping around the farm talking about the different points of development you could just about see a blueprint of the future of my place—and it looked pretty good, too. That young fellow said he'd have a soils man and an engineer up Tuesday morning to make a survey for the drain. Sure enough, bright and early Tuesday morning I saw them out there setting stakes and drilling holes all over that seep land and out in the cropland, too. They set stakes every 100 ft and then with a $1\frac{1}{2}$-in auger bit they drilled holes 6 ft deep at each one of these stakes, testing the soil every foot of the way down. When they got through I had as good a picture of the different types of soil under the surface as I had of that on top.

"They said I had a clay dike holding up the water that would ordinarily move along under the ground without causing any harm. This ponded underground water caused an accumulation of alkali salts at the surface as well as waterlogging the land, and it would just keep spreading—which certainly was the case, since the school had reported it was starting to come up in their basement over one-half mile away.

"They figured it would cost me about $200 to dig a drain to take care of the situation. I didn't like the idea, as I had already dug three drains just like the one they wanted, but I could see from that underground picture they had made why my drains had never worked.

"I finally gave them the go-ahead, and the soil conservation district dragline moved in. Everything went along right on schedule, moving forward every day at the rate these engineers said it would, and the walls of that bank were just like they had been pictured to me. I felt pretty good until the day my $200 budgeted for the job ran out. I'd spent money like that on three other ditches, and here I'd spent the required amount on this one and the water wasn't running in it any more than it was in the others. That young soils man wouldn't listen to it, though. He had his soils map there and showed me that in just 50 ft more we'd cut the clay dike.

"That made sense to me. I'd already spent $200, and if 50 ft more would do the job at a few cents a foot, it was a pretty good gamble.

"He missed his mark by less than 3 ft. At $47\frac{1}{2}$ ft the dragline pulled out a chunk of dirt and it looked like a dam had broken. The water poured through the bank like a small river, and has been running steadily for two years. You'd think they had broken through a cement wall instead of that innocent-looking red streak about 6 in thick that slanted up from where the water broke through.

"Last year my swamp pasture dried up, and the school tells me its basement rooms are dry too. The crops surely looked nice on the adjoining fields. I think this year I'll plow up the swamp grass and be able to farm that land too."

Drainage Through Control of Irrigation Water. The A. F. Apodaca farm, near Santa Fe, N. M., containing 60 acres formerly had a wet alkali area of 10 to 15 acres that produced practically no crops for a long period of years. This area could not be drained economically, on account of a railroad dyke and lack of nearby conservancy drain ditches. Apparently waste irrigation water had been allowed to accumulate on it ever since the railroad dyke had been built. The upper 50 acres were leveled, and soil-saving dykes, new lateral ditches, gates, turnouts, and drops were constructed. Proper

irrigation methods have been followed, and irrigation water has been carefully controlled. The 10 acres of the lower area have been smooth-leveled, bordered, and developed as irrigated pasture. Nearly all of the area had a fair to good crop of forage plants during the past growing season. This was probably the most economical way to handle the wet-alkali problem on this field.

Drainage in the Pacific Northwest. The supervisors of the Puget Island Soil Conservation District, on the lower Columbia River, in Washington, have requested and received technical assistance from the Soil Conservation Service on several drainage projects. The most important group drainage project completed in 1945 was the Grove Slough Pumping Station, located on Puget Island. This project included installation of two 10,000 gpm drainage pumps. It was completed at a cost of approximately $14,000 and directly affects the drainage on 140 farms including 3,800 acres of highly productive silt loam bottom land.

Before the pumping plant was completed, the annual value of dairy products averaged approximately $64 per acre. In 1946 it averaged $91 per acre—an increase of $27, much of which is due to better drainage.

Diking Commissioner Ture Oman says, "I believe you can safely say the permanent water table has been lowered at least 8 in. This permits us to work the land about 60 days earlier in the spring. The legumes no longer drown out, and we get 60 days more pasture per year."

A group drainage project was undertaken in Skagit County, Wash., in cooperation with the Skagit County Soil Conservation District and the local drainage district. A local contractor excavated 2½ mi of outlet drainage ditch to proper depth, cross section, and grade and installed a new tide box and farm bridges at a total cost of $7,500. This cost, prorated over the 2,000 acres benefited, equals $3.75 per acre.

This project was recently inspected by a group of Skagit County farmers on a county-wide crop and dairy tour conducted by the county agent. At this meeting George Brooks, a farmer cooperating in the project, made the following statement: "The completion of this drainage project before the heavy June rains of this year saved my 160 acres of cannery peas from total flooding and destruction." The peas had a gross value of about $190 per acre.

Asbestos Cement in Farm Building

(Continued from page 14)

sidewalls and roof — are in themselves one of the best fire insurances a farmer can have.

Asbestos cement materials can stand relatively high working temperatures. A sustained working temperature of 450 F is easily withstood. Intermittent working temperatures can go to 600 F and above, because the asbestos fiber does not start to lose its strength and its water of crystalization until 750 F is reached, and does not lose all of its water of crystalization until about 1600 F. Therefore, combustible constructions, even those with acceptable time-temperature ratings, are made more firesafe by sheathing them with asbestos cement.

Several types and many colors of asbestos siding are normally available to cover and beautify old and new farm houses.

Permanent fireproof asbestos roof shingles in several types and colors are excellent for residence and farm buildings where long service and maximum fire protection is desired.

Flat and corrugated asbestos cement sheets in several thicknesses are available for permanent maintenance-free exterior siding and interior lining of practically every type of farm and industrial structure.

Because asbestos cement materials are easy to keep clean and sanitary, and fulfill the sanitary requirements of the U. S. Public Health Service and milk shed control officials, they are the ideal material for dairy barns, milk houses, and milk-processing structures.

Much money can be saved by using asbestos cement materials in any kind of structure. For example, in our homes. We can save money by lining all closets with asbestos cement board to save the plaster and lath, that today cost around $1.50 per square yard and still has to be painted or papered every few years.

Taking Stock of Farm Machinery Research

(Continued from page 21)

engineer. Scientists in all fields, among the very best, are located at state and federal experiment stations, available to work together in attacking problems.

Says Roy M. Green, dean of engineering, University of Nebraska: "If the experiment station is to be of maximum value in working out applications in agricultural engineering, it will be necessary to draw freely from the resources of many other men of science and engineering. Our problems are so interrelated that few really important projects can be adequately studied by drawing upon the resources of single individuals or from only one special interest group. It would seem that agricultural engineering problems could best be attacked where it is possible to call upon the resources of the physicist, the chemist, the bacteriologist, and the other men of science, and upon the electrical, mechanical, and the chemical engineer."

Industry has many problems which only research can answer. Many of these are common to the whole industry or segments of the industry. The Agricultural Research Committee of the Farm Equipment Industry was formed to keep the public service research agencies informed on these problems and to assist in solving some of them. The solving of common problems in industry calls for cooperative effort by engineers with the plant breeders or other scientists. It is obvious, for example, that, if uniform precision planting of sugar beets is to be perfected, single-germ beet seeds which will permit seed selection and breeding will be needed. No matter how good a machine is, precision planting is not possible without predictable seed. Also, either a field-conditioned corn or a postharvest conditioner is essential before field shelling of corn will become practical.

Once the basic data is available and a method of procedure on one phase of commodity production is completed, then industry can move ahead in developing equipment to apply this information with the assurance that machines developed will do a job for the farmer which will result in increased yields for him.

Research should, in my judgment, be done across the board on a commodity basis. Dr. E. C. Aucter, formerly USDA agricultural research administrator and now president of the Hawaiian Pineapple Association, has recommended that every state experiment station director hold a round-table discussion with all section heads on each proposed research project. Each head could in this way indicate his interest and his group's responsibilities in the various projects. Each group would conduct research in its particular phases. In this way—and only in this way—can all phases be attacked and all variables isolated and studied individually.

It was along that line of thinking that agricultural engineers in the Department of Agriculture outlined a project on hay research. The project in outline form required 20 typewritten pages. The subject-matter groups have not yet developed the details of the project, but the major headings indicate its scope. Note the interdependence of one phase on the others: Soil and climate conditions, 17 divisions; seedbed preparation, 26 divisions; seeding hay crops, 34 divisions; rootbed maintenance, 36 divisions; plant breeding, 28 divisions; pest and plant disease control, 22 divisions; weed control, 15 divisions; time of harvest (maturity), 14 divisions; harvesting, 25 divisions; conditioning hay, 67 divisions; hay storage, 32 divisions; seed production, 10 divisions; processing . . . ; marketing . . . ; hay nutrition, 35 divisions.

After this entire hay project is plotted, work under way or completed will be checked to determine areas still to be studied.

The coordinated procedure outlined will obtain results that are final. The Research and Marketing Act is promoting such research. Dividing a major project in that way and making assignments to various states and agencies, will direct work on all phases, suggest areas for replication, and minimize unnecessary duplication. Cotton mechanization is a good example. This over-all project has been discussed by not only the subject-matter people of one state but also by all states in the cotton belt. All interested states have requested and been assigned segments of the main project.

Mathematics of a Cumulative-Drop Planter

By E. V. Collins and C. S. Morrison
MEMBER A.S.A.E. JUNIOR MEMBER A.S.A.E.

WITH any cumulative-type dropping mechanism the accuracy of selection for a complete hill is somewhat lower than the accuracy of each individual selection operation. The accuracy obtained with the planter set for four seeds per hill differs from the accuracy when set to plant three seeds per hill, etc. The engineer should be equipped to predict the planting accuracy for known conditions of equipment and seed regardless of whether the crop is to be drilled or planted in hills of any desired size.

In a recent research project, all tests of an experimental dropping mechanism were made to determine the accuracy with which each seed was selected. Three mathematical probability expressions were derived which predicted the accuracy with which hills of any desired number of seeds would be accumulated. An abbreviated derivation of these equations follows:

Let n = number of selection operations to cumulate each hill
p_0 = probability of obtaining zero seeds from each selection
p_1 = probability of obtaining one seed from each selection
p_2 = probability of obtaining two seeds from each selection
$q = p_0 \times p_2$
k = number of faulty selection operations
h = number of seeds by which a hill may differ from n seeds
P_n = probability of obtaining exactly n seeds per hill
P_{n+h} = probability of obtaining $n+h$ seeds per hill
P_{n-h} = probability of obtaining $n-h$ seeds per hill.

(NOTE: The probability of obtaining more than two seeds by a single selection operation was assumed negligible.)

Expression for P_n:

n operations will give n seeds only if
k operations give zero seeds
$n-2k$ operations give one seed
k operations give two seeds.

Number of permutations of these operations is

$$\frac{n!}{(n-2k)!\,(k!)^2} = \frac{n(n-1)\ldots\ldots(n-2k+1)}{(k!)^2}$$

Then

$$P_n = p_1^{n} + n(n-1)\,p_1^{n-2}q + \frac{n(n-1)(n-2)(n-3)}{(2!)^2}\,p_1^{n-4}q^2 + \ldots \qquad [1]$$

Expression for P_{n+h}:

n operations will give $(n+h)$ seeds only if
k operations give zero seeds
$n-(2k+h)$ operations give one seed
$k+h$ operations give two seeds.

Number of permutations of these operations is

$$\frac{n!}{(n-2k-h)!\,(k+h)!\,(k)!}$$

Then

$$P_{n+h} = \frac{n(n-1)\ldots(n-h+1)}{h!}\,p_1^{n-h}p_2^{h} + \frac{n!}{(n-h-2)!\,(h+1)!}\,p_1^{n-h-2}p_0p_2^{h+1} + \frac{n!}{(n-h-4)!\,(h+2)!\,(2)!}\,p_1^{n-h-4}p_0^2p_2^{h+2} + \ldots\ldots$$

$$P_{n+h} = \frac{n(n-1)\ldots(n-h+1)}{h!}\,p_2^{h}\left[p_1^{n-h} + \frac{(n-h)(n-h-1)}{(h+1)}\,p_1^{n-h-2}q + \frac{(n-h)(n-h-1)(n-h-2)(n-h-3)}{(h+1)(h+2)(2!)}\,p_1^{n-h-4}q^2 + \ldots\right] \qquad [2]$$

Expression for P_{n-h}:

n operations will give $(n-h)$ seeds only if
$k+h$ operations give zero seeds
$n-(2k+h)$ operations give one seed
k operations give two seeds.

Number of permutations of these operations is:

$$\frac{n!}{(n-2k-h)!\,(k+h)!\,(k)!}$$

(NOTE: P_{n-h} was found to be the same as the expression for P_{n+h} except that p_0 and p_2 were interchanged wherever they occurred.)

Then

$$P_{n-h} = \frac{n(n-1)\ldots\ldots(n-h+1)}{h!}\,p_0^{h}\left[p_1^{n-h} + \frac{(n-h)(n-h-1)}{(h+1)}\,p_1^{n-h-2}q + \frac{(n-h)(n-h-1)(n-h-2)(n-h-3)}{(h+1)(h+2)(2!)}\,p_1^{n-h-4}q^2 + \ldots\right] \qquad [3]$$

The solutions of equations [1], [2], and [3] for a particular planter setting (i.e., given value of n) and with various values of h gave expressions for the probability of obtaining $n+h$ seeds per hill. Each of these expressions was in terms of p_0, p_1, p_2, and q. The probabilities for conventional corn planter settings of two, three, or four seeds per hill are given in Table 1. Similar expressions can be obtained for any desired number of seeds per hill.

TABLE 1. EXPRESSIONS OF CUMULATIVE DROPPING ACCURACY FOR CONVENTIONAL PLANTER SETTINGS IN TERMS OF SINGLE SEED SELECTION ACCURACY

Proportion of total hills containing	Cumulative dropping accuracy for various planter settings		
	$n=2$	$n=3$	$n=4$
0 seeds	p_0^2	p_0^3	p_0^4
1	$2p_0p_1$	$3p_0^2p_1$	$4p_0^3p_1$
2	p_1^2+2q	$3p_0(p_1^2+q)$	$6p_0^2(p_1^2+2/3\,q)$
3	$2p_2p_1$	$p_1^3+6p_1q$	$4p_0(p_1^3+3p_1q)$
4	p_2^2	$3p_2(p_1^2+q)$	$p_1^4+12p_1^2q+6q^2$
5	0	$3p_2^2p_1$	$4p_2(p_1^3+3p_1q)$
6	0	p_2^3	$6p_2^2(p_1^2+2/3\,q)$
7	0	0	$4p_2^3p_1$
8	0	0	p_2^4

(Continued on page 29)

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AUTHORS' NOTE: The authors desire to give credit to E. S. Allen, mathematics department, Iowa State College, for derivation of the probability expressions applied in this paper.

RESEARCH NOTES

A.S.A.E. members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest, whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mich.

USDA Notes on Tobacco Curing, Drying Ear Corn, Farm Buildings

By JANE TUTTRUP

Tobacco Curing Research Project. The development of a new type of curing for bright-leaf tobacco to reduce labor and fuel costs and improve quality is the aim of a new U. S. Department of Agriculture research project just approved under the Research and Marketing Act of 1946. The work will be done principally at the Tobacco Experiment Station, Oxford, N. C., where it will be facilitated by available equipment and technical personnel.

American bright-leaf tobacco growers are facing increased competition for foreign markets which they have been supplying for more than a century. Improved quality and reduced production costs will help them meet this competition.

The quality of properly-grown bright-leaf tobacco is maintained or lost by the curing process. Results of current studies to develop improvements in existing structures indicate the advisability of exploring the development of barns and equipment of totally different design. New types of heating equipment and controls offer infinite possibilities for developing more efficient curing procedures that can be carefully regulated to produce a higher quality of tobacco at lower fuel cost.

The studies in which the Divisions of Farm Electrification and of Tobacco, Medicinal and Special Crops of the Bureau of Plant Industry, Soils, and Agricultural Engineering, will cooperate with the North Carolina Agricultural Experiment Station and North Carolina Department of Agriculture are aimed at determining best ways for handling the crop with minimum labor and fuel and maximum control of temperature and humidity.

Preparing Cribs for Drying Ear Corn. Common types of corn cribs can be easily adapted for the drying of corn with forced heated air, says Leo E. Holman, USDA ag engineer with the Division of Farm Buildings and Rural Housing, in a paper before the recent A.S.A.E. winter meeting.. Holman's recommendations were based on several years' cooperative investigations with farmers by the Bureau of Plant Industry, Soils, and Agricultural Engineering and agricultural engineers of the Illinois, Indiana, and Iowa agricultural experiment stations.

Most cribs can be filled first and prepared for drying afterwards, Holman said, but ventilators previously installed for natural drying should be removed or blocked before filling if they interfere with uniform flow of air through the corn. A major principle in artificial drying, which he emphasized, is that air must travel equal distances through the corn in all parts of the crib. This usually means that sections of the crib must be made airtight with reinforced paper, canvas, or other materials.

It is better to supply air through a single duct or plenum chamber from which it is forced through the corn. Using several ducts makes it more difficult to obtain uniform air flow. The main plenum chamber should have a cross-sectional area of 1 sq ft for each 1,000 cfm of air flow. Smaller ducts result in air velocities too high for uniform drying.

Holman reminded the audience of the importance of husking ear corn as clean as possible and removing shattered or shelled corn before cribbing. Frequent moving of the elevator spout assists in getting even distribution of husks, silks, dirt, and shattered corn. The air will bypass areas where this debris accumulates.

The common double crib with overhead bins is easy to adapt for fan drying. The driveway, large in cross section, is satisfactory as a main duct. Both ends are sealed and the fan mounted at one end. Air blown into the driveway passes through the corn to the outer walls or to the upper surface of the corn. In the case of double cribs, however, it is frequently preferable to dry one crib at a time. It is then better to use canvas loosely covering a crib wall as the main duct instead of the driveway.

Other types of cribs that can be prepared for drying with forced heated air are double cribs without overhead bins, single cribs, curved-wall concrete cribs, temporary circular cribs of wire or snow fencing, and cribs with tight walls and perforated floors. Holman also mentioned the importance of checking depth of corn in the crib (allowing for settling) and slope of the corn surface.

* * * *

Four-Part Farm Buildings Research Project. Just approved under the Research and Marketing Act of 1946 is a series of specialized studies on functional requirements, materials, and construction methods for farm buildings, including structures for farm storage, to be undertaken by the USDA Division of Farm Buildings and Rural Housing in cooperation with other USDA agencies and several state experiment stations.

Billions of dollars will be spent by farmers within the next few years to construct and remodel buildings. Research data are needed on which to base designs of buildings for housing livestock and storing farm products that will assure more economical use of space, lower construction and maintenance costs, and higher quality products.

Material shortages and high prices are resulting in the use of materials which have not been well tested under farm conditions. Buildings as now commonly constructed frequently lack strength and make inefficient use of materials. Research conducted before a large volume of construction gets under way will help avoid erection of unsuitable or otherwise unsatisfactory buildings, and thereby contribute toward saving the farmers' dollars and conserving critically needed building materials.

The new work is in four fields — dairy structures and equipment, apple storage, grain bin design, and structural requirements and materials. The objects of the four-fold project are to investigate functional requirements, determine suitability of materials, develop improved and lower cost designs and construction methods, and improve equipment and product-handling procedures for farm buildings.

The housing of dairy cattle in stanchion versus loose-run and milking parlor barns will be studied under the climatic conditions typical of the mountain states and of the medium altitude areas of Idaho, eastern Oregon, and eastern Washington. In the coastal region of the Pacific Northwest the engineers will investigate the influence of design and arrangement of farm dairy structures and equipment on the quality of milk produced and on operating efficiency of the enterprise. In Wisconsin the plan is to compare the environment provided, the quality of milk produced, and the first and annual costs of operation with bank (basement) barns and above-ground barns. Dairy building layout in relation to labor requirements will be investigated in Illinois. A general objective is to develop more sanitary, convenient, and efficient housing for dairy calves and young stock. This work is in cooperation with the Bureau of Dairy Industry, the Bureau of Agricultural Economics, and the experiment stations of Oregon, Washington, Idaho, Utah, Wisconsin, and Illinois.

The projected apple storage research will develop the principles of design and operation of apple storage structures and equipment for the various commercial producing areas that will maintain quality of apples for market at economical price. Particular attention will be given to layout and design of buildings and equipment as influenced by local production and marketing practices and requirements, and to practical methods for more specific control of humidity. Investigations will include handling and operating practices in connection with the physical plant and their combined effect on the quality and marketability of the fruit. Studies will be centered at Wenatchee, Wash., and Blacksburg, Va., in cooperation with the experiment stations of those states, the Division of Fruit and Vegetable Crops and Diseases, and the Production and Marketing Administration.

The Division of Farm Buildings and Rural Housing will cooperate with the Grain Branch of the Production and Marketing Administration and the Iowa and Indiana experiment stations in developing plans

Mathematics of a Cumulative-Drop Planter

(Continued from page 28)

Example: A typical application of these relationships was to predict the cumulative dropping accuracy for a planting mechanism which performed single seed selection as follows: 92 per cent one's, 5 per cent zero's, and 3 per cent two's.

If four kernel hills were desired, the proportion of the total hills predicted to contain four seeds (Table 1) would be

$$P_4 = p_1^4 + 12p_1^2q + 6q^2$$

$$P_4 = .92^4 + 12(.92^2)\ (.05 \times .03) + 6(.05 \times .03)^2$$

$P_4 = .733 = 73.3$ per cent.

The hills predicted to contain three seeds would be:

$$P_{4\cdot1} = 4p_0(p_1^3 + 3p_1q)$$

$$P_{4\cdot1} = 4(.05)\ .92^3 + 3(.92)\ (.05 \times .03)$$

$P_{4\cdot1} = .156 = 15.6$ per cent.

The percentage distribution for all possible hill sizes (zero to eight seeds) would be predicted by repeated use of Table 1.

and specifications for mass-produced farm-type grain storage bins not subject to the common structural faults and weaknesses. Specimen bins will be obtained from manufacturers for observation and test in the field. New designs will incorporate appropriate features for mechanical drying.

In the fourth phase of this project, designs for experimental specimens of structural materials, members, panels, and assemblies of the types applicable to farm construction will be prepared and arrangements made with commercial, public, or institutional shops and laboratories for fabrication and test. Data on physical, chemical, and related properties of building materials, structural parts and assemblies pertinent to farm construction will be compiled and organized. Interpretation will be made of these data with particular reference to farm exposures and applications. Studies of suitability and performance of materials in actual farm service will be made in selected areas representative of different climates and types of farming.

North Dakota Notes on Poultry House Ventilation, Water Heaters, Barn Cleaners

By R. L. WITZ

PROJECTS carried on by the North Dakota Agricultural College agricultural engineering department, which lend themselves to the winter season, include studies on poultry house ventilation, testing of dairy water heaters, and barn cleaner operation.

The poultry house studies include farm testing of a new type of mechanical ventilation. Tests on the experimental poultry farm show that mechanical ventilation materially decreased mortality and maintained a more comfortable house. Farm tests this winter are being made to verify results obtained during the past two winters. High winds and low temperatures make this an ideal area to study ventilation under extreme conditions, and plans are to expand this work to other types of farm structures.

An extensive installation of watering devices in an open dairy shed, the sheep barn, and on an outside tank at the beef barn have been made on the college farm. The sheep barn installation is made on a temporary basis with pipes installed only 6 in below the ground level. Soil-heating cable thermostatically controlled is used to prevent freezing. Two installations in the open dairy shed include a commercially made, all weather drinking cup, and an insulated tank. The insulated tank is one designed for the farmer without a pressure water system, and is filled with water once or twice a day. Provision is made to prevent the heating element from burning out in case the cattle drink all of the water from the tank.

Comparisons in electrical consumption and operating characteristics are being made of two float heaters and one immersion heater at the beef barn. The float heaters are identical except for the size of the heating elements.

A barn cleaner, installed in the dairy barn on the campus, is being tested under severe winter conditions and a study of the time saved in dairy chores will be made.

These projects are carried on by W. J. Promersberger, Richard L. Witz, and Clarence F. Becker.

Hawaii Notes on Sugar Cane and Napier Grass Harvesting, Irrigation

By J. F. CYKLER

HAWAII has stepped up its research efforts through the establishment of agricultural engineering departments — in the Hawaiian Sugar Planters' Association headed by E. J. Stirniman, Hawaiian Pineapple Research Institute headed by Dr. Eugene G. McKibben, and the University of Hawaii department of agricultural engineering headed by Rene Guillou.

The H.S.P.A. agricultural engineers have been advancing rapidly with their programs of cane harvesting. Two types of cane-cutting equipment are necessary because of the difference between irrigated and unirrigated culture. This difference is due principally to the fact that sugar cane is grown in a furrow on 4½ to 6-ft centers in the irrigated regions. The cane must be severed close to the ground surface as cane left in the field will reduce sugar yields, since the sugar content is high in the lower portions of the stalk. The cutter mechanism must be able to cut while in a deep furrow. Yields of cane run between 80 and 120 tons per acre. In some areas a majority of the cane is not standing in an erect position but has fallen over. The stalk runs along the ground for a distance of 8 to 10 ft where it again becomes erect. In fields where this growth condition exists there is a junglelike mass of cane stalks, and the rows are completely hidden. Prior to harvest the cane fields are burned to reduce the trash content, but many times only fair burns are accomplished as a result of heavy rains soaking the cane. This adds to harvesting problems since cane should be free of soil and trash when delivered to the mill. The soils of Hawaii are very sticky when wet and are readily compacted by heavy equipment. Machines must be of such construction as to have a low weight per unit area of soil contacted.

Sugar lands may be steep and rocky with semipermanent irrigation distribution systems, such as the Waialua concrete flume. The irrigation distribution system prevents straight-through harvesting, as these concrete flumes produce areas of fairly short rows, in some cases from 100 to 450 ft. The cane is planted adjacent to these flumes which means there are no headlands, and harvesting equipment must be able to cut cane adjacent to the flumes.

R. A. Duncan on Hawaii has developed an experimental harvester for the unirrigated or flat culture type of plantation. His harvester is a one-row cutter with a side-mounted cutter bar using high-speed rotating disks. F. P. Gomes, on Oahu, has developed an experimental double-line cutter for use in irrigated culture. This machine employs double-acting, shear-type knives cutting in a vertical plane which serve to split the rows vertically, and double-reciprocating, ground-type knives which sever the cane at the ground surface. The ground knives have a 12-in stroke and run between 50 to 80 cycles per minute. It was necessary to alter the track-type tractor used for the mounting of this harvesting equipment. The tractor was raised two feet in order to pass the harvested cane under the machine, and the driving controls were relocated to a position in front and above the cutting mechanism.

The University of Hawaii has started work on the mechanization of napier grass harvesting. A No. 2 International Harvester harvester-chopper has been selected as initial equipment. It is hoped that this machine with very little modification can be tractor-mounted. Auxiliary power appears to be necessary. Problems encountered are very high yields up to 100 tons per acre in five cuttings one year, furrow irrigation, no headlands, high stooling, and tall growth. Overhead irrigation projects have been included in the napier grass harvesting problem in order to obtain land under flat culture for machinery field trials.

An underground 8-in reinforced concrete pipe distribution system with Harris automatic control valves is now being installed at the Poamoho substation. This system will be used for macadamia orchard irrigation studies.

Utah Notes on Drainage Research

By O. W. ISRAELSEN

THE Utah Agricultural Experiment Station and cooperating agencies are devoting special attention to research concerning the drainage of irrigated lands. A state-wide survey of the activities of Utah drainage districts, including the design, construction, and maintenance of drainage systems and the results of drainage—conducted cooperatively with the Soil Conservation Service, USDA—has been in progress for two years. Results of this survey are being assembled for publication.

Technical drainage studies, with special reference to leaching alkali salts and to the feasibility of drainage by pumping in the Delta Area, Utah, have been conducted cooperatively with the U. S. Regional Salinity Laboratory and with local drainage districts during 1946-47. The leaching studies, now nearly completed, have given very satisfactory results. Studies of drainage by pumping are still in progress.

Recently, a new cooperative research project concerning drainage of irrigated lands was initiated. This project, which is especially concerned with the physical feasibility and costs of drainage by pumping, was made possible by the receipt of a generous research grant from the Utah Power & Light Co. Other agencies, notably the Amalgamated Sugar Co. and the Draper Irrigation Co., are also contributing to this cooperative research. Three test wells in the Lewiston Area, Utah—in which lack of adequate drainage of 10,000 acres has been a serious problem for many years—indicate that the high water table is caused in part by very deep blue clay of low permeability. The six drainage districts in this area recognize the need for improved drainage methods toward which the research agencies are working. Test wells to find the feasibility of pumping ground water for drainage in the Draper Area, near Salt Lake City, are being drilled as this report is written.

Water Report

THIS year, most of the Bureau of Reclamation projects, except in the drought-stricken Southwest, have had sufficient irrigation water to mature their crops profitably, and still leave ample hold-over storage for future operations. In the drought-stricken Arizona and New Mexico projects, the situation is critical. Reserves are below normal in all reservoirs of those projects and are near record lows on several.

Ground water and stream flow measurements for August, made by the U. S. Geological Survey, show a range of from 2,300 per cent of normal in southwestern Oklahoma to 0 per cent in south central South Dakota and southern California. From "Water Report." *The Reclamation Era*, October, 1947.

NEWS SECTION

Nominations for 1948 A.S.A.E. Officers

THE Nominating Committee of the American Society of Agricultural Engineers has placed in nomination the following members of the Society for the various elective offices to be filled at the next annual election of officers, to be conducted by letter ballot next month:

For President:

Arthur J. Schwantes, head, agricultural engineering department, University of Minnesota.

For Councilor:

C. J. Scranton, chief engineer, Harvester Division, Allis-Chalmers Manufacturing Company.

Martin Ronning, chief engineer, Power & Machinery Division, Minneapolis-Moline Power Implement Company.

For Councilor:

D. G. Carter, professor of farm structures, University of Illinois.

W. V. Hukill, senior agricultural engineer, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

For Nominating Committee:

J. P. Fairbank, professor of agricultural engineering, University of California.

R. A. Glaze, chief engineer, Weyerhaeuser Sales Company.

P. R. Hoff, extension agricultural engineer, Cornell University

G. B. Nutt, head, agricultural engineering department, Clemson Agricultural College.

B. G. VanZee, chief engineer, automotive division, Minneapolis-Moline Power Implement Company.

D. G. Womeldorff, manager of rural sales, Public Service Co. of Northern Illinois.

The by-laws of the Society provide that by March 1st of each year the secretary of the Society shall mail each member, entitled to a vote, a ballot stating the names of the candidates for elective office to be filled at the next election.

Winter Meeting Draws Large Attendance

A RECORD attendance of 664 filled to capacity the meeting rooms for most of the sessions of the A.S.A.E. Winter Meeting at the Stevens Hotel in Chicago, December 15, 16, and 17. The program followed closely the schedule published in advance of the meeting.

Meeting rooms were filled to capacity during most of the sessions, indicating a lively interest in the subjects scheduled for attention. There was a minimum of informal discussion and visiting in the corridors outside the meeting rooms during the sessions, but it was active before each session and continued at length and in serious vein after each adjournment.

An open meeting of the National Joint Committee on Fertilizer Application, held in conjunction with the A.S.A.E. meeting, drew the attendance and interest of a strong representation of farm machinery men interested in equipment problems of fertilizer application.

The power and machinery session on flexible power transmission summarized the characteristics of present available means in relation to the requirements of various farm machine drives in current production.

Direct engine-driven power take-offs were presented as a development which has been under way for years and still presents the challenge of apparent utility which it is difficult to reconcile with some of the other considerations of tractor design.

Discussion of the A.S.A.E. standard on power take-off speed showed that most of the designers favor it as a workable compromise, and shudder at the thought of the complications which would result from any change. It was pointed out that some of the newer small tractors using higher speeds are intended only as motive power for specially designed equipment, rather than as general-purpose power sources for interchangeable use with equipment designed for standard speeds.

Self-propelled field machines proved an interesting subject for discussion, the engineering-economic boundary of relative advantage between them and separately powered units not yet being clearly defined.

Influences of research, specialized design and modification for large farm operations, and manufacturer's refinement of design for the quantity market were brought out in the session on new machines.

Wiring is still a problem child of rural electrification as indicated by interest in the session on this subject.

A long look ahead, toward future possibilities in "Uses of Radiation in Agriculture" proved a popular subject for the evening session of the Rural Electric Division. A lively discussion followed the introductory presentations on high-frequency sources, lamp sources, and possible agricultural applications.

The rural electric men also showed themselves alert to current opportunities in labor-saving applications, and to the potentialities of electric power and equipment in that field. Their attention to labor-saving principles and specific devices reflected considerable recent progress in thought as to the ultimate economy of electric use.

Grain and forage crop drying proved to be anything but a cut-and-dried subject in the day devoted to it by both the rural electric and farm structures men. Progress reports showed variations in approach and results which suggest a number of "unknowns" still to be revealed by research before any best methods or equipment types can be indicated. Some progress was noted in technical definition of crop conditioning requirements.

Attention to factors in functional design characterized the other sessions of the Farm Structures Division, with specific consideration of sanitation, labor efficiency, grain storage requirements and other items, as influenced by arrangement, materials, and structural detail.

A representative group of the Soil and Water Division reported new activities and data in the related fields of drainage, irrigation, upstream flood control, flood routing, soil mechanics, runoff control, terracing, and farm practices influencing conservation. Their discussion reflected the urgent demands on their technology for means of providing extensive soil protection and improvement and water control, with the investment appeal of low costs and quick returns.

A.S.A.E. Meetings Calendar

February 2 — CHICAGO SECTION, Builder's Club, Chicago.

February 6 and 7 — PACIFIC COAST SECTION, Yuma, Ariz.

February 12 to 14 — SOUTHEAST SECTION, Hamilton Hotel, Washington, D. C.

March 26 and 27 — SOUTHWEST SECTION, Grim Hotel, Texarkana, Texas.

April 29 to May 1 — MISSOURI SECTION, Hotel Muehlebach, Kansas City, Mo.

June 21 to 24 — ANNUAL MEETING, Multnomah Hotel, Portland, Oregon.

October 21 and 22 — PACIFIC NORTHWEST SECTION, Columbia Gorge Hotel, Kansas City, Mo.

Chicago Section Meeting

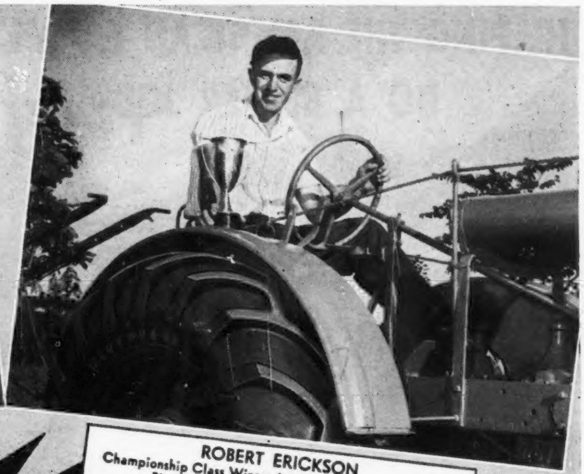
THE next meeting of the Chicago Section of the American Society of Agricultural Engineers is scheduled to be held Monday evening, February 2, at The Builder's Club, 22nd floor, 228 N. LaSalle St., Chicago. It will be a dinner meeting, and the general subject for the program will be "Designing for Efficient Merchandise." Reservations for the dinner should be made in advance with the Section Secretary Howard C. Rutt, agricultural sales division, Public Service Co. of Northern Illinois, 72 W. Adams St., Chicago.

Fore Heads Tennessee Section

THE Tennessee State Section of the American Society of Agricultural Engineers, at a meeting on November 15, elected as its new chairman, Julian M. Fore, head, education section, engineering division, Tennessee Valley Authority. Other officers elected included a vice-chairman, J. C. Hundley, University of Tennessee extension agricultural engineer, and secretary and treasurer, W. C. Wheeler, a member of the agricultural engineering staff of the same institution.

The meeting was held in the agricultural engineering building on the campus of the University of Tennessee at Knoxville. The principal program feature of the meeting was a talk by Jim Anderson, University of Tennessee extension specialist on the farm credit improvement plan. Representatives of the Tennessee Student Branch of A.S.A.E. presented an outline of proposed activities to be carried out in cooperation with the Section. A suggestion was considered that at the next annual meeting of the Section arrangements be made for a visit to some industrial plant in the vicinity in which the meting is held.

HARRY SCHOGER, Plainfield, Illinois
Men's Class Winner in National plowing matches at Big Rock, Illinois, and Wheatland, Illinois



ROBERT ERICKSON
Championship Class Winner in National plowing matches, Big Rock, Illinois, and Wheatland, Illinois

Firestone

CHAMPION GROUND GRIPS

CHOICE of CHAMPIONS

IN ALL THREE 1947 NATIONAL PLOWING MATCHES

GENE FERGUSON, Oskaloosa, Iowa
Open Class Contour Winner, Webster City, Iowa

CHAMPION Plowmen know that the performance of their tractor tires can "make" or "break" them in a plowing match. They must have tires that take hold and pull — on soft ground — on hard ground — on sod — on stubble. They must have tires that take a full, clean bite, a center bite — tires that plow right through under all conditions.

That's why winners in the three big national matches this fall (Big Rock, Wheatland, Illinois and Webster City, Iowa), plowed on Firestone Tires. They could not afford to gamble with a "broken center" tire that might let them down by clogging up with trash, slipping and spinning.

Firestone Champion Ground Grips will perform for you on every job just like they perform for champion plowmen. They always take you through faster, without slipping. That means time and money saved.

Specify Firestone Champions when you order a new tractor or when you buy replacements for your present tractor. See your nearest Firestone Dealer or Store today.

Only FIRESTONE CHAMPION GROUND GRIPS TAKE a "CENTER BITE"

Listen to the Voice of Firestone every Monday evening over NBC

Oregon A-E Staff Additions

TWO additions have been made recently to the agricultural engi neering staff of Oregon State College, according to announcemen by department head J. B. Rodgers. John W. Wolfe will be in charg of teaching and experimental work in soil and water conservation, wit the rank of assistant professor. Mr. Wolfe is a graduate of Sout Dakota State College in agricultural enginering with a master's degre from the University of Idaho. He saw four years' service in the Arm during World War II, and more recently was connected with the Soi Conservation Service.

The other new staff member is David Long who holds the rank o instructor and is assisting in teaching agricultural engineering classe and experiment station work. He has completed his work toward a agricultural engineering degree from Oregon State College, which h will receive in June of this year.

Weaver Is Extension Director

ACCORDING to a recent announcement, David S. Weaver is resign ing as head of the agricultural engineering department of Nort Carolina State College to accept appointment, effective January 1, a assistant director of the North Carolina Agricultural Extension Servic

Professor Weeaver has been a member of the faculty of North Caro lina State College since 1923, and in his new position he will be re sponsible for the coordination of subject matter information to be dis tributed to the farmers of the state and will co-ordinate the work o the specialists on the extension staff. He will also keep in close touc with the research work now being handled by the state's agricultur experiment station, and in an effort to keep a closer relationship wit farmers and their families he will bring to the college's research labora tories the technical problems arising in the field.

New Arc Welding Competition Announced

AGRICULTURAL engineering students are specifically included a eligible to compete with other undergraduates in engineering, i the 1947-48 engineering undergraduate award and scholarship progra sponsored by the James F. Lincoln Arc Welding Foundation.

A recent announcement of rules and conditions for the competitio bases awards, as in previous years, on student papers on arc welde design. Closing date for the mailing of entries is May 15, 1948. Typi cal subjects suggested in the agricultural field include maintenance o farm machinery or buildings, and farm equipment which can be bui by welding on the farm.

A total of 77 individual awards ranging from $1000 to $25, an seven $250 scholarships to the schools of the three highest individu award winners, are offered.

Additional information may be obtained by writing to A. F. Davi Secretary, The James F. Lincoln Arc Welding Foundation, Clevelan 1, Ohio.

PROFESSIONAL DIRECTORY

Farm Machinery Short Course in Panama

A THREE-WEEK short course in farm machinery for employees of the Ministry of Agriculture, Republic of Panama, was held at Divisa, October 6 to 25, on the recommendation and under the supervision of Earle K. Rambo, agricultural engineer and adviser to the Ministry. Agronomists, mechanics, tractor operators, and other machine operators employed by the Ministry made up the enrollment of 66 students.

Purpose of the course was to give these men an increased appreciation of the amount and importance of available information on the proper operation and maintenance of farm machinery, and the importance of following closely the manufacturers' operating and maintenance instructions.

Norton C. Ives, chief of the agricultural engineering department, Inter-American Institute of Agricultural Sciences, assisted during the last week of the course. Representatives of American manufacturers of farm equipment, fuels and lubricants, and tires made up the balance of the teaching staff. It was generally agreed that the course was highly successful, and the students suggested that further instruction of this nature be offered.

In commenting on the instruction, Mr. Rambo pointed out that the Ministry does extension work in farm machinery with actual operation on a custom basis, and that the men instructed are directly engaged in this work.

International Commission of Agricultural Engineering

A MEETING of the International Commission of Agricultural Engineering was scheduled to be held in Paris, November 24 and 25, particularly to consider cooperation with the Food and Agriculture Organization of the United Nations, and the creation of an International Center of Agricultural Machinery, according to an announcement recently received.

The last previous meeting of the Commission was held at Gembloux, Belgium, in October, 1946. The Commission was founded during the International Congress of Agricultural Engineering at Liege in August 1930, and designated as an independent and self-governing body. Its four technical sections are devoted to soil and water, farm buildings, farm machinery and electrification, and scientific organization of labor in agriculture.

Personals of A.S.A.E. Members

T. E. Duncan has resigned his position with Clemson Agricultural College as in-service teacher in the agricultural phases of vocational education, and is now employed in research work with the Georgia Agricultural Experiment Station at Experiment, Georgia.

Phillip L. Edwards has been promoted from the position of manager, products division, Manhattan Rubber Division, Raybestos-Manhattan, Inc., to that of assistant manager of the central district of the Company with headquarters at 810 Empire Bldg., Pittsburgh, Pa.

Paul L. Erdner has been named manager of a new department that has been set up by the Blaw-Knox Co., to be known as the universal building and farm specialties department. One of the first of the new items for which this department will be responsible is a crop drier for drying small grains, tobacco, peanuts, and hay, preparatory to storage.

Ladd Haystead, who has been editing "The Farm Column" of Fortune Magazine, announces the opening of his own business as an agricultural counselor, specializing in farm markets and procurement, agricultural studies, and public relations programs. His new place of business will be Suite 2032, Shelton Hotel, New York City.

Samuel H. McCrory, onetime chief of the former USDA Bureau of Agricultural Engineering, and more recently chief, hemp and fiber flax division, Production and Marketing Administration, USDA, but now retired from government service, is at present in Cairo, Egypt, as one of six agricultural experts whom the Food and Agriculture Organization of the United Nations is providing on request as consultants to Near East governments in the preparation of a plan of action for stepped-up agricultural production. The men are experts in irrigation, drainage, animal husbandry, crop production, nutrition, and agricultural statistics. As the consultant on drainage problems, Mr. McCrory brings to his assignment a wealth of experience accumulated during his many years with the U. S. Department of Agriculture.

J. Mostella Myers is now associate agricultural engineer at the Florida Agricultural Experiment Station. The first research problem to which he has been assigned is investigating the efficiency of barn drying of hay in that state. Because of the great amount of rainfall and high relative humidity in the state, the hay drying problem there is quite critical.

Personals of A.S.A.E. Members

(Continued from page 36)

Edward R. Murphy has resigned as assistant chief engineer of the Gypsum Association to become managing director of the the Vermiculite Research Institute with headquarters at 2540 Eastwood Ave., Evanston, Ill.

Austin W. Zingg recently resigned as agricultural engineer with the Missouri Department of Resources and Development, to accept appointment as supervisor of a research project on wind erosion mechanics established by the Soil Conservation Service, USDA, in cooperation with the Kansas Agricultural Experiment Station. The project is being set up under the new Hope-Flannagan Act and is of a regional character.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Adams, Merrill L.—Agricultural engineer, Shell Agricultural Laboratory, P. O. Box 1531, Modesto, Calif.

Armstrong, Ray E.—Extension associate in agricultural engineering, Iowa State College, Ames, Iowa.

Bailey, H. G.—Research and development director, Dearborn Motors Corp., 15050 Woodward Ave., Detroit 3, Mich.

Blaser, Wilfred A.—Engineer, Innes Company, Bettendorf, Iowa

Cook, George E.—Sales engineer, Imperial Oil, Ltd. (Mail) Kyle, Sask., Canada.

Costello, J. R.—Production engineer, Dearborn Motors Corp., Detroit 3, Mich. (Mail) 22718 Brittany.

Crees, Merrill F.—Farm electrification representative, Sears, Roebuck, and Co. (Mail) 233 14th Ave., South, St. Cloud, Minn.

DeRose, Roy L.—Rural electrification extension specialist, University of Nebraska, Lincoln, Nebr.

Ewart, George Y.—Agricultural engineer, drainage and irrigation research, Kekaha Sugar Company, Kekaha, Kauvai, T. H.

Ferguson, G. W.—Publisher, The Eastern Dealer, 1094 Drexel Bldg., Philadelphia 6, Pa.

Furbeck, Paul L.—Rural representative, Kansas Power & Light Co., Manhattan, Kans. (Mail) R. R. No. 4.

Gibson, William C.—Refrigeration salesman, International Harvester Co. (Mail) 1314 Talbot Ave., Jacksonville, Fla.

Glassford, G. L.—Director of engineering, The Chek-Chart Corp., 624 S. Michigan Ave., Chicago 5, Ill.

Greeson, Claritt B.—Divisional engineer and head of designing dept., Rockford Works, J. I. Case Co., Rockford, Ill.

Hockaday, Edmund E.—Industrial sales and timber products, Rilco Laminated Products, Inc., St. Paul, Minn. (Mail) 879 East Jessamine.

Kelso, Albert H.—District manager, industrial division, Timken Roller Bearing Co., 2534 S. Michigan Ave., Chicago 16, Ill.

Lal, Uma Shanker—Agricultural engineering dept., Allahabad Agricultural Institute. (Mail) c/o S. Khamani Lal, Bilari (Dist) Moradabad U. P., India.

Lewis, H. A.—Lecturer in agricultural engineering, University of Saskatchewan, Saskatoon, Sask., Canada.

Ludlow, Lynn S.—Agricultural field engineer, Rural Electrification Administration, USDA. (Mail) Box 135, Spanish Ford, Utah.

Meyer, Herbert G.—Graduate student in agricultural engineering, University of California. (Mail) 3129 Divisadero St., San Francisco 23, Calif.

Phillips, Ross A.—Agricultural engineer, Howard S. Sterner Co. (Mail) R. R. No. 2, Tippecanoe, Ohio.

Rutter, Alvah E.—Chief engineer, Rockford Works, J. I. Case Co., Rockford, Ill.

Sarquis, Armen V.—Land-use specialist, Bureau of Reclamation, USDI. (Mail) P. O. Box 1269, Visalia, Calif.

Scarseth, George D.—Director of research, American Farm Research Assn., 300 Schultz Bldg., Lafayette, Ind.

Schill, Bernard J.—Product engineer, Rockford Works, J. I. Case Co., Rockford, Ill.

Schram, Jack R.—Instructor in agricultural engineering, Michigan State College, East Lansing, Mich.

Shriver, G. Harvey—Student engineer, John Deere Tractor Works, Waterloo, Iowa. (Mail) 215 Hammond Ave.

Skinner, Thomas C.—Instructor in agricultural engineering, University of Florida, Gainesville, Fla.

Spohn, Earl M.—Engineer in charge, implement div., The Budd Co., 1350 E. Atwater St., Detroit, Mich.

Applicants for Membership

(Continued from page 38)

Spyker, Lawrence—Agricultural engineer, The Ohio Power Co. (Mail) P. O. Box E, Lima, Ohio.

Taylor, Melford D.—Agricultural engineer, Public Service Co. of Northern Illinois. (Mail) 501 E. Main St., Streator, Ill.

Wineland, Robert E.—Instructor in agricultural engineering, Pennsylvania State College, State College, Pa.

TRANSFER OF GRADE

Baker, James V.—Sales dept., Sears, Roebuck & Co. (Mail) 4640 Roosevelt Blvd., Philadelphia 32, Pa. (Junior Member to Member)

Lien, Ray M.—Engineer, Shoshone Project, Heart Mountain Div., Bureau of Reclamation, USDI. (Mail) P. O. Box 354, Ralston, Wyo. (Junior Member to Member)

Marburger, Ausmus S.—Superintendent of production, New Holland Machine Co., New Holland, Pa. (Junior Member to Member)

Ramsey, Hugh G.—Agricultural engineer, Choptank Electric Cooperative, Inc., Denton, Md. (Junior Member to Member)

Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this Bulletin the following listings still current and previously reported are not repeated in detail. For further information see the issue of AGRICULTURAL ENGINEERING indicated.

Attention is invited to the desirability of checking on the housing situation when considering a new location.

POSITIONS OPEN: 1946 JUNE — O-506. SEPTEMBER — O-516. DECEMBER—O-526. 1947 MARCH—O-543. APRIL—O-552. MAY—O-564. JUNE—O-567, 569, 571. JULY—O-574. AUGUST—O-576, 577, 579. SEPTEMBER—O-581, 582, 584. OCTOBER—O-585, 587, 588, 589, 590, 591. NOVEMBER—O-592, 593, 594, 595, 596. DECEMBER—O-597, 598, 599, 600, 601, 602, 603, 604.

POSITIONS WANTED: 1946 FEBRUARY—W-207. JUNE—W-320. SEPTEMBER—W-337. 1947 FEBRUARY—W-373. APRIL—W-389. MAY—W-395, 398, 101, 103. JUNE—W-105, 106. AUGUST—W-114. SEPTEMBER—W-119, 120. OCTOBER—W-124. NOVEMBER—W-125, 126, 127, 128. DECEMBER—W-129, 130, 131, 132, 133, 134.

NEW POSITIONS OPEN

SALES REPRESENTATIVES (10) to set up dealers, get them started, and help them with sales of fertilizer. Sales ability and knowledge of agricultural problems, especially soils, crops, and fertilizer required. Individual initiative and willingness to work can overcome handicaps in formal education. Territory open in almost any state. Age 21-50. Mileage or car and travelling expenses paid. Salary open. O-605

CIVIL ENGINEERS for design and field survey work in soil conservation flood control program. Location, Iowa. BS deg in civil engineering, agricultural engineering, or equivalent. No experience required for beginning position; one year for higher rating. Opportunity to acquire classified Civil Service status. Salary $2644 - $3397. O-606

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER desires design or development work in farm power and machinery or product processing field, in private industry in West. BS deg in mechanical engineering 1946, University of Kansas and in agricultural engineering 1947, Washington State College. War service in U. S. Navy, including 9 months in refrigeration maintenance and repair. Soil conservation engineering (P-1) in Indian Service, 6 months. No physical defects. Available Feb. 1, 1948. Single. Age 23. Salary $2880. W-135

AGRICULTURAL ENGINEER desires research, design, or development work in power and machinery or rural electric field, in private industry. West Coast location preferred. BS deg in agricultural engineering, 1942, Kansas State College. Farm background with 4 yrs farming in eastern Kansas. Student assistant on research projects 4 yrs. Tool design 1 yr. Instrument test engineer in aircraft factory 2½ yrs. War service in naval electronic technician program. Farm service supervisor for electric utility 2 yrs. No physical defects. Available in 30 days or less. Married. Age 32. Salary $5000. W-136.

AGRICULTURAL ENGINEER desires work as sales or service manager with farm equipment manufacturer. BS deg in agriculture, with major in agricultural engineering, 1940, University of Illinois. Farm background. Research assistant in agricultural engineering while in school. Soil Conservation work, 3 mo. Manager of farm equipment store, 1 yr. On present job 6½ yrs. as farm equipment technical supervisor for national retail distributor. No physical defects. Available March 1, 1948. Married, age 30. Salary $7500. W-137